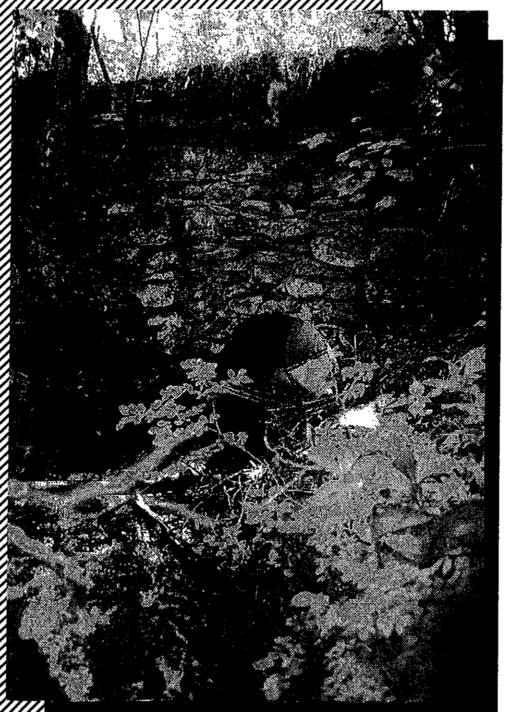
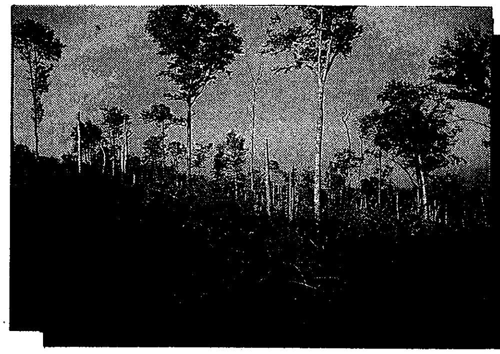
IMPACT ASSESSMENT OF TIMBER HARVESTING ACTIVITY IN VERMONT

FINAL REPORT
MARCH 1990

UNIVERSITY OF VERMONT,
SCHOOL OF NATURAL RESOURCES
IN COOPERATION WITH
VERMONT DEPARTMENT OF FORESTS, PARKS, AND RECREATION
&
ASSOCIATED INDUSTRIES OF VERMONT





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March 1990

Mr. Paul Hannan, Commissioner
Department of Forests, Parks and Recreation
Vermont Agency of Natural Resources
103 South Main Street, 10 South
Waterbury, VT 05676

Dear Paul:

In 1988, under contract to the Vermont Department of Forests, Parks and Recreation, an interdisciplinary study team at the University of Vermont began the "Impact Assessment of Timber Harvesting in Vermont" project. As you know, this project involved both an inventory of timber harvesting in Vermont and an evaluation of the major types of impacts that might result from such activities. Here is the final report for that study. It provides a fairly thorough coverage of project procedures, findings, and recommendations.

This type of project directly addresses some of the important issues associated with the sustainability of development relative to Vermont's forest-based resources. Hopefully, the study results will contribute to a greater understanding of the current relationships between these resources and timber harvesting, and will assist you and legislature in formulating appropriate public policy.

Sincerely,

Carlton M. Newton
Associate Professor and
Project Director

CMN/md
Enclosure

IMPACT ASSESSMENT OF TIMBER HARVESTING IN VERMONT

School of Natural Resources, University of Vermont

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STUDY TEAM

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ACKNOWLEDGMENTS

This project has been a true cooperative effort from the beginning. Support for the project came from a private-public partnership between the Vermont Department of Forests, Parks and Recreation and Associated Industries of Vermont. The Governor's Forest Resources Advisory Council not only reviewed the project's design, periodic progress, and results, but also provided much appreciated general counsel. Numerous professional foresters and logging contractors throughout the state cooperated by providing information about known timber harvesting activities in their area. Private landowners (with the exception of only one individual) and public agencies permitted access to the study sites, and willingly provided much needed background information about the operations. The Vermont Natural Heritage Program of the Agency of Natural Resources cooperated by performing evaluations of selected harvesting operations in light of their potential negative impact on threatened and endangered species.

There are also several individuals who deserve special recognition for their assistance on the project. As part of his Master's degree in Natural Resources Planning, David Brynn was the project's field investigator and one of the analysts for the water quality component of the study. Without David's practical experience and hard work, this project would not have been possible. Robert Turner designed the computerized data base and the necessary data entry procedures. Data organization, error checking, and computer input were done by Michael Turner. Maureen Douglas and Marie Brown were secretaries to the study team. Virginia Scharf assisted with report editing, while the layout and production of the final report was done by Ted Lyman. Sue Storey was responsible for the design of the report's cover.

This project turned out to be a larger, more demanding effort than most of us expected at the outset. Therefore, special thanks goes to not only the members of the study team for their patient cooperation, but also their families for their obvious support and understanding.

Carl Newton
Project Director

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Executive Summary

In 1988, the Vermont state legislature passed Act 232 (S295) in response to a growing public concern that timber harvesting practices might have deleterious, long term negative impacts on Vermont's future forests and on related forest based resources. Under the auspices of Act 232, the Commissioner of the Department of Forests, Parks and Recreation is charged with recommending to the Vermont legislature specific initiatives deemed necessary to mitigate undue adverse effects of timber harvesting in the state. In mid-summer 1988, the Department contracted with the School of Natural Resources at the University of Vermont to conduct an interdisciplinary, cooperative study designed to provide the Commissioner with sufficient information to prepare the requested report.

The study had two objectives: to characterize timber harvesting operations in the state, and to identify and categorize the major types of impacts that result from timber harvesting in Vermont. The first objective was intended to provide basic descriptive data about the number, sizes, and characteristics of timber harvesting operations. Work done under the second objective was to provide an assessment of the nature and frequency of timber harvesting impacts, positive as well as negative, on the following specified resources: aesthetic values, archaeologically sensitive sites, threatened and endangered species, timber quality and productivity, water quality, and wildlife habitat.

Following a detailed information needs assessment, data for 78 recently completed, commercial timber harvesting operations were gathered during late summer 1988 and throughout the 1989 summer. Operations were randomly selected from throughout the state in a way that would provide reliable information at the state level.[1] Data collection for a selected operation involved both extensive field examination and an interview of a person directly involved with the harvesting operation. Where there were choices to be made during the site investigation, established field methodology intentionally dictated measurement or evaluation of the specific resources that might be most negatively impacted by the timber harvesting. Once all of the data were collected, the computerized data base was thoroughly analyzed by the nine-person study team. Although individuals were primarily responsible for different portions of the study, findings and recommendations were endorsed by the entire team.

1 The Department was given the opportunity to also designate specific operations to be evaluated. Since such designations would be at the expense of operations in the statistical sample, no special designations were made.

This summary only presents the highlights of the study. Those wishing more complete discussions of the findings and recommendations should refer to the full report.

Status of Timber Harvesting

For the time period studied, the study indicates that at least 754 individual harvesting operations were completed. Harvested areas for the 78 harvesting operations that were visited ranged in size from 2 to 1,108 acres, with an average of 93 acres. Therefore, an estimated 70,122 acres, or nearly 1.6% of the state's timberland experienced some type of harvesting activity during the year. The northern portion of the state had larger operations, averaging 137 acres as opposed to 53 acres for the southern region.

Seventy-three percent of sampled operations occurred on timberland owned by the non-industrial (i.e., not forest products industry) private sector. Nearly 12% of harvesting operations were on forest industry land, and the remaining 15% were distributed across various categories of public ownership. The average size of operation for industrial harvesting was substantially larger than for other categories of private ownership (369 acres versus 51 acres). Thus, because of the larger average operation size, harvesting on industrial land represented approximately 48% of total statewide acres that had some harvesting activity.[2] There was only a slight difference in average operation size between public and private categories. Forty percent of harvests were conducted on lands enrolled in the Use Value Appraisal (UVA) program; 37% were eligible but not enrolled in the program, and 23% were not eligible due to type of ownership (i.e., public) or size of holding. For operations eligible for the UVA program, those not in the program averaged 135 acres in size, whereas operations on UVA lands were approximately half the size.

Silviculture was the stated primary objective of more than 83% of operations. For the remaining sampled operations, land development was the primary stated objective, and these tended to be much smaller in average size (7 acres versus 103 acres for silviculture). Cutting practices varied widely, with larger operations having a mix of silvicultural methods, including selection cutting, group selection, and clearcutting. Selection cutting occurred on 81% of operations, and clearcutting occurred on 23% of operations. For operations conducted under a single silvicultural regime, the operation sizes tended to be smaller. Fifteen percent of operations were totally selection cutting, averaging 35 acres in size; total clearcuts represented only 9% of the sample and averaged 15 acres per operation.

2 To calculate an estimated total statewide acreage (e.g., the total acreage of forest industry land harvested), multiply the percentage of the operations in that category, times the estimated total number of operations in the state, times the average size of operation for that category (e.g., 12% times 754 times 369 acres equals approximately 33,400 acres of industrial timberland harvested statewide).

Professional assistance by either a forester or wildlife biologist was indicated on nearly 77% of operations. However, the nature of that involvement was highly variable, ranging from general reconnaissance to supervision of close-out activities. Where a professional forester was involved in some way, the forester was a consulting forester 42% of the time. The average size of operations without known forester involvement was half the size of those with forester involvement (48 acres versus 107 acres).

Harvesting contracts were known to exist for more than 70% of operations. However, the details of those contracts were quite variable. Where there were contracts, 82% had some water related provisions and 77% had some conditions that addressed aesthetic issues.

From an operational perspective, the median duration of a harvest was from 1 to 3 months. The most common method for designating trees for harvest was the marking of individual trees (52% of operations, an average size of nearly 70 acres, and 39% of total statewide harvested area). While diameter limit selection was much less common (8% of operations), the substantially larger average harvest area made it the method used on 37% of total statewide harvested acres. Fifteen percent of statewide harvested area was harvested using logger's-choice selection (19% of operations with an average operation size of 72 acres). Rubber-tired skidders were used on 92% of operations and were occasionally supplemented by other types of equipment. Horses were used on 3% of operations. The preferred skidding method was tree-length skidding (nearly 80% of operations). Not surprisingly, there were fewer operations (10%) where wholetree harvesting was done, but these operations tended to be relatively large and therefore represented approximately 36% of statewide harvested area. Most harvesting operations removed a wide mix of products, ranging from fuelwood to veneer logs. As expected, the larger the operation, the greater the variety of products removed.

Aesthetic Values

Visual impacts of timber harvesting operations were examined from the point of view of public and quasi-public outdoor use areas. Those areas included paved public roadways, recreation areas, designated trails (hiking, bicycle, bridal, cross-country skiing, and snowmobile), streams, and lakes and ponds greater than 25 acres.

Eighty-four percent of harvesting operations studied either could not be seen from a public use area, had a positive impact, or had a minimal negative impact. Of those that had positive or minimal negative impacts (34 operations or 43% of the total), many were selection cuts, but in several cases they were small clearcuts along historic boundaries such as fencelines. These small clearcuts, usually under 10 acres, looked much like agricultural openings and added visual diversity to the landscape or opened up a distant view.

Sixteen percent of operations could be seen and had moderate or more serious negative visual impacts. Nine operations (12% of the total) were rated as having moderate impacts, one (1%) was moderate to severe, and two (3%) had a severe visual impact. Most of these operations occurred in the northern part of the state, and the most severe had not benefited from the involvement of a professional forester. These operations demonstrated some clear problem areas, primarily in size of cut, cuts on the horizon line, abrupt transition edges, poorly reclaimed landing areas, and excessive slash. The most serious impacts were the result of "economic clearcuts" in which poor quality, spindly trees were left scattered over the cut area. These cuts also occurred on hillsides that were highly visible from public roads. The traditional method of screening with a vegetative buffer was not effective in these situations.

Archaeological Resources

Archaeological sites are a key link to understanding Vermont's cultural heritage. Historic archaeological sites dating to the past 250 years can provide significant information about local and regional historical developments and processes that cannot be obtained from written records alone. For most of the past 10,000-year period since people took up residence throughout Vermont, prehistoric archaeological sites provide the *only* record of human history and culture.

Archaeological resources are nonrenewable. Once disturbed, the effect is permanent. Furthermore, site loss is cumulative in nature, a fact that is particularly relevant when considering long term preservation. To emphasize the cumulative aspect of these impacts, the following estimates are ten-year projections of the sample data.

Of the roughly 7,500 harvesting operations that may be expected to occur in the next decade, it is estimated from the inventory that at least 69% or nearly 5,200 will contain some visible evidence of an historic site. Potential prehistoric site areas are likely to be present on 22% or more than 1,600 operations. This estimate is particularly relevant because there are only 1,300 prehistoric sites currently located and recorded in the entire state. At least 1,650 operations will contain historic residential sites centered around house foundations with a number of associated outbuildings. Mill sites are likely to be present on at least 190 operations, other types of historic features are likely to be present on more than 960 operations, and stone walls may be seen in roughly 4,800 harvesting sites. There is no way to identify types of prehistoric sites that might be present, except to say that they may include fairly large residential bases and smaller satellite camps dating from 8500 B.C. to the time of European arrival.

We can offer only a preliminary evaluation of potential disturbance. Several trends seem likely to continue. First, there will be a conscious effort to avoid most visible structural remains themselves, although some 200 structures may be directly affected during the next decade. Secondly, truck roads, skid trails and log landings are likely to disturb potentially significant archaeological deposits at a large number of historic and prehistoric sites. At both historic and prehistoric sites, it is anticipated that there will be roughly 850 occurrences of site disturbance during the next decade.

Threatened and Endangered Species

Although timber harvesting has potential for enhancing habitat of endangered or threatened species of plants and animals, we assumed that timber harvesting on sites with threatened or endangered species would result in adverse impacts for those species unless logging contracts contained special provisions. We relied upon the Vermont Natural Heritage Program to review mapped locations of the sampled timber harvesting operations and to compare these to known locations of threatened and endangered species.

When timber harvesting impacts endangered species, the long-term impacts must be viewed as a cumulative threat that usually is not offset by a period of recovery. In this regard, there is some concern that the level of harvesting in spruce-fir forests in northeastern Vermont may threaten the continued existence of one endangered bird species (spruce grouse) and three other species under special consideration (three-toed woodpecker, black-backed woodpecker, and gray jay).

Two harvesting operations were located near regions where rare plants were known to exist, but none of the 78 operations corresponded with mapped, specific locations of threatened or endangered plants. One logging operation did take place near the site of a common loon, an endangered animal species in Vermont. This site was on public land and presented a threat because of disturbance to the nesting birds.

Timber Quality and Productivity

Timber quality and productivity may be influenced by harvesting through alterations in a forest's biota or its physical site. In evaluating these impacts, both soil and vegetative parameters were evaluated. Soil-related parameters included soil disturbance, i.e., exposure of bare mineral soil, and soil erosion. Vegetative parameters included damage to residual trees, changes in species composition, adequacy of residual stocking, and abundance and species composition of regeneration.

Mineral soil was frequently exposed but erosion was never common, regardless of this disturbance. Mechanical damage to stands ranged from 0 to 46% of residual basal area, but few operations had 15% or more of their residual basal area damaged. These findings compared favorably with those reported from a study of logging operations in the Appalachians. Overstory elimination or change in species composition within the overstory were detected on about one-fifth of the plots examined. Of these, 60% resulted from overstory removal for either silvicultural, agricultural, or development purposes. The remaining 40% resulted from a shift in overstory cover type because of preferential species or size-class removals. The majority of plots that shifted overstory cover type changed from softwood or mixed-wood to hardwood cover types.

Adequacy of residual stocking varied with forest type and silvicultural treatment. In general, selection cuts or thinnings in hardwoods appeared to adhere to published silvicultural recommendations. But, with the exception of hemlock, selection cuts or thinnings in softwood and mixed-wood often left understocked residual stands. Insufficient basal area was also common after shelterwood harvests. Again, with the exception of hemlock, this tendency seemed more pronounced for softwood and mixed-wood cover types. Approximately one-quarter of clearcut plots contained residual stems. Although some may have been consciously retained for wildlife den or perch trees, many were probably of undesirable species or of poor quality and were left for economic reasons.

Most operations appeared to have adequate advance regeneration. For most plots without advance regeneration, its absence was probably not a serious problem because most were either in silvicultural practices designed to encourage subsequent reproduction, or because reproduction was not needed since the lands were being converted to non-forestry uses. In summary, timber harvesting appeared to have minimal impact on most soil and vegetative parameters examined.

Water Quality

Timber harvesting activities were examined for impacts to water quality and compliance with existing statutes. Lingering water quality impacts, including increased stream temperature and turbidity, woody debris, and petroleum spills, were infrequent and insignificant. The primary impact to water quality was increased sedimentation. Sediment increases were observed in nearly one-third of the operations that involved a stream, lake, or wetland. Although some sediment originated from truck roads, skid trails, and log landings, the primary source of sediment appeared to be improper stream crossings. Over one-half of operations with stream crossings exhibited sediment impacts.

Three primary State regulations pertain to timber harvesting operations and water quality: Act 250, Stream Alterations statutes, and the Water Pollution Control Act. Of these, only the Water Pollution Control Act applied to the timber harvesting activities examined. The Act requires that silvicultural operations discharging waste must obtain a permit unless the Acceptable Management Practices (AMP's) are followed. Conformance with the AMP's ranged widely. Protective buffer strips adjacent to waterbodies were generally well maintained and effective in minimizing water quality impacts. However, when protective strips were not maintained, stream temperature and sedimentation increases were observed. Stream crossings often failed to meet the AMP's. In addition, post-harvest recreational use of transportation networks was common, and operation closeout activities were generally insufficient to withstand these uses. Finally, some AMP's pertaining to spacing of erosion-control measures appeared to be excessive while others pertaining to stream crossings were ineffective in maintaining water quality.

Wildlife Habitat

Effects of timber harvesting on wildlife were determined by evaluating indicators of conscious efforts to manage habitat for wildlife; by examining harvest operations for evidence of specific wildlife management practices; and by taking field measurements that allowed prediction of future stand conditions. Several indicators suggested that wildlife habitat had been considered before or during timber harvesting on 62% of the operations sampled. Thirty-three percent of the 78 harvesting operations satisfied the most definitive criteria for wildlife habitat considerations.

Based on field examinations, specific practices to enhance wildlife habitat were evident on more than half the operations. The most common practice was retention of snag and cavity trees. Retaining mast trees, regenerating aspen, releasing apple trees, and daylighting logging roads were other practices that favored wildlife. Nineteen of 20 sites that might have been suitable for deer wintering habitat were managed appropriately for winter cover. Statistical comparisons indicated that most of these practices occurred independently of differences in land ownership, type of harvest operation, or region of the state.

No direct, detrimental, short-term impacts on wildlife were identified in the 78 timber harvesting operations studied. On the contrary, a high proportion of operations exhibited conspicuous management practices that indicated a desire to improve wildlife habitat. On a statewide basis, habitat diversity is probably being impacted positively by forest harvesting. From an area perspective, changes in cover type as a result of the harvesting operations accounted for only 2% of the acreage studied. The only concern about wildlife habitat that surfaced from our analysis was the possible loss of softwood forest types as they are converted to other types. The cumulative effects of cover-type changes are more significant in softwood types because of their importance as cover for a number of featured wildlife species and because of their relative rarity.

Recommendations

From the varying individual orientations of the study team members, there were specific timber harvesting operations that contained substantial negative impacts. However, from a statewide perspective these did not have many characteristics in common and were not of sufficient numbers to be considered representative of timber harvesting in the state. **Therefore, it is the unanimous recommendation of the study team that new legislative initiatives designed to regulate timber harvesting in Vermont are not justified at this time.**

Clearly, there are opportunities and a need for improved harvesting practices. However, given the lack of a common problem characteristic, it would seem that the responsibility for insuring any improvements rests jointly with loggers, public officials, professional foresters, forest landowners, and the general public. **We further recommend that public and professional educational programs in timber harvesting and land stewardship be enthusiastically continued and expanded, and that existing statutes be more fully implemented.**

A summary of recommendations that are specific to the individual categories of potential impacts are listed below. Complete presentations and discussions of these recommendations are given in the full report.

Aesthetic Values

- The Planning Division of the Vermont Agency of Natural Resources should assume responsibility for the identification of forested areas of statewide and regional visual importance. The Department of Forests, Parks and Recreation should consider incentives for well designed harvests in these visually sensitive areas.
- The Vermont Department of Forests, Parks and Recreation and the University of Vermont's Extension Service should educate landowners, foresters, and loggers as to how negative visual impacts can be reduced.
- Demonstration areas should be developed by the Department of Forests, Parks and Recreation to show ways in which the full spectrum of cutting practices can be done with minimal visual impacts.

Archaeological Resources

- The Vermont Department of Forests, Parks and Recreation should, within this year, convene a small study group to improve the estimation of predictable site loss and to identify educational, and perhaps legislative, mechanisms for counteracting apparent trends.
- The Vermont Department of Forests, Parks and Recreation should include in timber harvesting publications a brief discussion of the need to preserve Vermont's rich cultural heritage, and a summary of recommended management practices that might mitigate archaeological site loss.

Threatened and Endangered Species

- Copies of maps produced by the Vermont Natural Heritage Program should be distributed to all county foresters, state lands foresters, and as many consulting foresters as possible.

Timber Quality and Productivity

- Public and professional education should emphasize that timber harvesting operations should be conducted with equipment, and at times of the year, which minimize soil disturbance unless such disturbance is intentional and necessary to meet silvicultural goals.

- The Department of Forests, Parks and Recreation and the Extension Service should jointly develop educational programs which explain to forest landowners the types of managerial decisions, and their likely results, that must be made relative to timber harvesting.

- The Department of Forests, Parks and Recreation and the Extension Service should jointly prepare printed guidelines that would assist forest landowners in selecting a logging operator. These guidelines should be made generally available through the Extension Service, and county and consulting foresters.

- Landowner education programs should recommend that provisions be made in clearcutting timber sale contracts that specify that most residual material be felled and either removed or left on site.

- Where selection harvests are to be implemented and advance regeneration is inadequate, small group selections rather than single tree selections are preferred because they create canopy openings more favorable to the establishment of regeneration.

Water Quality

- Design of timber harvesting transportation networks should anticipate post-harvest use, and cost-share programs that facilitate long-lasting design should be encouraged.

- Transportation network layout and closeout activities should be conducted so that post-harvest uses are accommodated without increased erosion and sedimentation. In situations where post-harvest use is not appropriate, closeout activities should actively restrict access by installing sufficiently large drainage structures.

- The use of log waterbars on skid trails and broad-based dips on truck roads should be encouraged.

- The recommended spacing of drainage structures on truck roads and skid trails should be reexamined in light of current research.

- Skid trails and truck roads should be more carefully located with respect to stream crossings. The number of stream crossings should be minimized, and crossings should be made in the most appropriate locations.

- Fords of permanent streams should not be allowed except under unusual circumstances.
- Crossing streams over brush fords should be discouraged.
- The AMP's should clearly specify what constitutes a stream to make it clearer as to when the AMP's pertaining to streams should be applied.
- Methods to reduce stream sedimentation from stream crossings should be evaluated in detail.
- Logging operators should be encouraged to continue the extremely important practice of minimizing disturbances to protective strips.
- Additional research on the short and long term water quality impacts of timber harvesting operations that utilize customary management practices is essential.
- Educational efforts aimed at reducing water quality impacts should continue, and demonstration areas on public and private lands should be established.

Wildlife Habitat

- Wildlife management information should continue to be integrated into education programs for foresters and loggers.
- The Department of Forests, Parks and Recreation should seriously consider requiring a wildlife habitat assessment as part of management plans required by the Use Value Appraisal program.

* * * * *

The above recommendations are made by the study team to the Commissioner of the Vermont Department of Forests, Parks and Recreation. The recommendations pertain only to the resources evaluated. Approval or endorsement of these recommendations by any public or private agency or organization has not been sought, and therefore should not and cannot be assumed.

1 INTRODUCTION

In 1988, the Vermont state legislature passed Act 232 (S295) in response to a growing concern that timber harvesting operations might have deleterious, long-term negative impacts on future forests, and the related forest-based resources. Under the auspices of Act 232, the Commissioner of the Department of Forests, Parks and Recreation was charged with recommending to the Vermont legislature specific initiatives deemed necessary to mitigate undue adverse effects of timber harvesting in the state.

In late spring 1988, the Commissioner and researchers at the School of Natural Resources at the University of Vermont discussed the possibility of conducting an interdisciplinary study designed to characterize the types and significance of impacts from timber harvesting operations in the state. During those discussions, it became obvious that not only was there little information regarding the impacts of timber harvesting, but that there was also very limited comprehensive information about the status of timber harvesting activities in the state. Reliable summary data about the annual number, size, and characteristics of timber harvesting operations in the state did not exist. Without such basic data, neither the School nor the Department would be able to assess the overall significance of any specific impacts.

In July, the Department of Forests, Parks and Recreation and the School of Natural Resources entered into a contract for a cooperative research project designed to assess the impacts of timber harvesting operations in the state. There have been other recent studies in the region that have focused on timber harvesting (DeHart 1982, Associates in Rural Development 1986, and The Ireland Group 1988), but none have been as interdisciplinary as this one.

The study had two objectives: to characterize timber harvesting operations in the state; and to identify and categorize the major types of impacts that result from harvesting operations in Vermont. The first objective was intended to provide basic descriptive data about the annual number, sizes, and characteristics of timber harvesting operations in the state. The work done under the second objective was to provide an assessment of the nature and frequency of timber harvesting impacts, positive as well as negative, on aesthetic values, archaeologically sensitive sites, threatened and endangered species, timber quality and productivity, water quality, and wildlife habitat resources. This is the final report for the study.

Forest Resource Base

Before discussing the design and results of the study, it would be helpful to review what is already known about the forest resource base in Vermont. The most recent data that we have describing the state's forest resources are in the statistical report for the fourth forest survey of Vermont, conducted in 1982-1983 by the Northeastern Forest Experiment Station, USDA Forest Service (Frieswyk and Malley 1985).

As of 1983, there were 4,544,000 acres of forest land in the state. This amounted to 77% of Vermont's land base, and represented a 5% increase since 1966. A little more than 122,000 acres of this forest land was not considered available for timber harvesting either because of the poor productivity of the land or because the land has been removed from production through statute or administrative designation. Thus of the forested land, more than 97%, or 4.4 million acres, was classed as timberland, which is defined as being suitable for the production of commercial timber products. From 1973 to 1983, there was a 45% increase in the area covered by sawtimber stands, a 25% increase in growing stock volume (net volume of all commercially valuable trees greater than five inches in diameter), and a 22% increase in sawtimber volume. During the same ten-year period, growing stock net growth was more than three times the growing stock removals. The state's forest resources have clearly been maturing, shifting to larger sawtimber-sized trees, and accumulating volume.

The Forest Service inventory divided the state into northern and southern regions, with each containing approximately equal areas of timberland. The northern region was made up of Caledonia, Essex, Franklin, Grand Isle, Lamoille, Orange, Orleans, and Washington counties. Counties in the southern region were Addison, Bennington, Chittenden, Rutland, Windham, and Windsor. The northern region had more timberland acreage in spruce-fir forest cover types, while the southern region had more acreage in hardwood cover types.

Forest Land Ownership

There are two broad categories of forest land ownership, public and private. Public sector ownership of the state's timberland amounted to less than 10% of the area. Privately owned timberland thus amounted to nearly 4.0 million acres, with only 409,600 controlled by forest industry. In conjunction with the above mentioned forest resources inventory, the USDA Forest Service surveyed the private forest landowners to ascertain their number and characteristics, and to describe their attitudes towards timber harvesting, forest management, and recreational uses of their land (Widmann and Birch 1988).

The Forest Service landowner survey estimated that there were 61,900 private forest landowners, including individuals, corporations, partnerships, and trusts. It was not only a diverse ownership group, but one that seemed to have distinct differences between the northern and southern regions. The southern region had nearly twice as many private owners as the northern region. Differences in sizes of ownership are primarily in the smaller size classes. For ownerships with less than 20 acres, the south had 22,800 owners, whereas for the northern region the comparable number was only 3,400. The northern and southern regions had nearly equal numbers of private owners with more than 50 acres of forest land. The northern region had more than three times as much acreage in the very large forest land ownerships of more than 5,000 acres.

The primary reason given for owning forest land was because it was part of a residence or a farm (43% of the owners, representing approximately 1.5 million acres). Only three percent of the owners consider timber production to be either the primary or second most important reason for owning forest land. However, the owners in this group had relatively large tracts and controlled 23% of the private forest land.

Of particular interest were the attitudes that private owners had towards timber harvesting. Irrespective of the reasons for owning the forest land, nearly 65% of the owners, controlling nearly 3.1 million acres of forest land, expected to harvest timber from their land during the next decade. If not restricted to the ten-year period, owners of more than 90% of the state's privately owned timberland intended to have a harvest some time in the future. Owners of less than five percent of the forest land indicated a clear intent never to harvest timber as long as they owned the land.

Thus, not only were the forests maturing, but a substantial percentage of the forest land area might be available for harvest. This study of the level of harvesting activity and the nature and extent of associated harvesting-induced impacts is both appropriate and timely.

2 STUDY DESIGN

Introduction

At the outset of the study, we had to make a few operating assumptions which would not only limit the scope of the study, but also provide consistency across the various disciplines involved.

Impacts

The enabling legislation called for the study to evaluate timber harvesting impacts on aesthetic values, archaeological resources, threatened and endangered species, timber quality and productivity, water quality, and wildlife habitat. Impacts on soil resources are included in the discussions of timber quality and productivity, and water quality.

The commonly held perception that all timber harvesting impacts are negative is not correct. Careful and thoughtful harvesting operations can and should have positive impacts on the forest resources of the site. Therefore, the team felt obligated to conduct a study that considered not only negative impacts but also the potential positive benefits of timber harvesting operations.

Population Definition

The study design called for a representative sampling of all timber harvesting operations throughout the state. Faced with the problem of relating the results of the study to annual activities, the definition of a qualifying timber harvesting operation had to be developed which was not only temporal but also compatible with the Commissioner's needs. On the one hand, commercial timber harvesting operations that were currently under way might be acceptable. However, much could be done to the site, both positively and negatively, in the process of completing a harvesting operation. Therefore, it seemed most appropriate to the study team that commercial harvesting operations that were recently finished, irrespective of how long they were under way, would represent a reasonable population from which to sample. However, it was also important that the operation be fairly current so that details of how, when, and under what circumstances the operation was conducted might not have been forgotten. It was decided that all commercial operations completed during the period extending from 1 August 1987 to 1 August 1988 would be considered a part of the population.

A commercial timber harvesting operation was defined to include any operation for which forest products were harvested and commercially removed from the site. Such a definition included not only traditional timber harvesting, but also land clearing and reclamation operations that were sufficiently large to warrant the commercial harvest, sale, and removal of timber. Single-dwelling land clearings probably would not be included because the amount of timber cut rarely justifies its commercial sale and removal.

It was believed that there should be no restriction on land ownership. If a commercial harvesting operation was finished within the stipulated time period, then it was included in the population. Thus operations on federal, state, municipal, private, and corporate ownerships were included for possible sample selection. To have done otherwise would have biased the characterization of the statewide situation.

Because this was a study of timber harvesting activity in the state, it was not appropriate to report on the assessments of individual site visitations. Anonymity of sites, operators, and landowners was not only appropriate, but was also necessary to receive widespread support and cooperation.

The Department was given the option of requesting an assessment of any specific operation, even if it did not fit the population definitions. Results of such a directed assessment would therefore not have been considered representative of the statewide situation and would have been reported separately. No operations were designated for such an assessment.

Data Collection

In designing this study, there was the choice of conducting detailed, in depth assessments of a few harvesting operations, or visiting several sites as efficiently as possible, focusing the assessments on dominant critical issues. In an effort to study timber harvesting on a truly statewide basis, the decision was to favor the latter approach.

It was not reasonable to have the entire study team visit all of the sampled sites. Therefore, for purposes of objectivity, consistency, and field efficiency, one individual from outside the study team was responsible for all of the data collection. The Department of Forests, Parks and Recreation assigned this task to a field forester with broad experience in planning and overseeing harvesting operations.

While on site, the field investigator was frequently faced with several choices as to where to spend time. For any given category of impact, if there were several potential skid trails, streams, or viewing locations to investigate, the choice was always to select that site which might be most severely (negatively) impacted by the operation. In this way, the team felt assured that potentially serious, detrimental impacts would probably not be overlooked, while still conducting the study in both a timely and comprehensive manner.

Information Needs Assessment

The information needs assessment was a carefully structured process intended to identify exactly what data needed to be measured or observed, and how they would be collected. After carefully reviewing the desired end products, the process started with each member of the study team identifying impact assessment strategies, necessary informational needs, analyses they would use to generate information, specific data items necessary and sufficient to perform the analyses, and the most promising data sources. Data measurement specifications and definitions were then developed consistent with existing literature, locally accepted practices, and current administrative guidelines or statutes. With little editing, these data items and measurement techniques were incorporated into a single set of field procedures for team review. It was clear that not only would it be impossible to gather all of that data in one field day, but also that the respective levels of precision were not consistent across all parameters.

Working toward mutual consistency without compromising accountability, iterative negotiations with team members eventually resulted in a package of definitions and data collection instructions, and tally sheets that appeared viable. Data collection involved both field examination and an interview with someone knowledgeable about the harvesting operation. Successive trials and modifications resulted in procedures and tally sheets that were acceptable to the entire study team.

The last step of the needs assessment involved the confirmation that nothing critical was omitted by submitting data to the various analyses. Each member of the study team used data from a trial run of the field procedures for a trial of their respective analyses. This resulted in the identification of some final refinements to the field procedures. Technical details of the field procedures appear in Appendix A. A copy of the final tally sheets appears in Appendix B.

Sample Selection

The Department of Forests, Parks and Recreation was responsible for compiling the list of timber harvesting operations that met the criteria for possible observation. County Foresters were given the task of trying to identify all qualifying operations in their respective counties. Depending on the county, the County Foresters contacted consulting, federal, and industrial foresters, loggers, timber truckers, mill owners, and wildlife biologists in an attempt to make their lists as complete as possible. From these various sources, the County Foresters identified qualifying operations, plus some basic descriptive information. The desired descriptive information included a mapped location of the operation, the type of landowner (state, federal, municipal, non-industrial private, industrial, or other), the apparent primary harvesting objective (silvicultural, agricultural conversion, development, other, or unknown), and the name and telephone number of a contact person knowledgeable about the operation. For operations selected for observation, this contact person was asked to provide detailed information about the location, access, harvesting objective, and operating characteristics of the operation.

The task of compiling these county lists was a substantial undertaking, but the importance of this work was central to the success of the study. A truly comprehensive list was needed if the sample was to be considered representative of the state as a whole. Ample time was given so that the County Foresters would have every opportunity to prepare complete lists. However, there was no illusion that the lists would be 100% complete. The intention was to give enough time so as to minimize the probability of any systematic errors. Given the number of times that operations were included on lists from different sources, the study team felt reasonably assured that there were few, if any, systematic reporting errors.

The next task was to compile a statewide master list after reviewing each county submission to be sure that no operation was included more than once. In accordance with the operating principle of confidentiality, the details of these lists have not been published or released by the study team. There were 754 operations on the master list spread across all of the state's counties (as is traditional in statewide forestry reports, Grand Isle and Franklin counties were combined).

A stratified random sample of 78 operations was selected from this master list.[1] Each county was sampled and the number selected per county was proportional to the number of operations listed by county. We had originally hoped to sample 90 operations in total, but because of early leaf fall we settled with 78. The issue of leaf fall was important because we wished to be consistent insofar as aesthetic values were concerned.

Data Analysis and Results

Once the data were collected and checked for obvious errors, they were entered into a computer data base and made available to the individual members of the study team. Individual analyses were conducted and then reviewed by the entire team. If serious negative impacts were found, attempts were made to interpret what, if any, relationships existed between the impacts and the following operation attributes: region (northern versus southern), land owner-

1 The Department was given the opportunity also to designate specific operations to be evaluated. Since such designations would be at the expense of operations in the statistical sample, no special designations were made.

ship (private versus public), whether or not silviculture was the stated prime objective of the operation,[2] enrollment in the Use Value Appraisal (UVA) program, whether or not wholetree harvesting techniques were used on the operation, and professional forester involvement. The study was not designed with any particular statistical tests of hypotheses in mind. Therefore, many interpretative comparisons frequently could not be tested statistically because there were insufficient numbers of observations. However, several statistical tests were made where possible and reported in the appropriate sections.

The data gathered during the interviews and site visits provided an interesting insight into the extent and nature of timber harvesting in the state. A consequence of not being able to visit and evaluate all of the 754 operations, is that sample data were used in the analyses and therefore the reported statistics are necessarily estimates. The statistics that are reported in the following sections represent only some of the results of the data analysis.

The accuracy of the estimates, i.e. the ability to estimate the true statewide population value, could not be directly tested or evaluated. However, several steps were taken to try to insure the greatest accuracy possible. All field and interview procedures were documented. A pilot study was conducted as part of the informational needs assessment. The documented field procedures and the pilot study were reviewed externally by representatives of the Department of Forests, Parks and Recreation, the Governor's Forest Resources Advisory Council (FRAC), and forest industry. Individual team members were responsible for conducting the necessary analyses associated with their areas of primary responsibility. All major calculations were then checked by at least one other team member. Preliminary tables and results were reviewed by the Department and FRAC. If questions arose, the data were reviewed and, if necessary, calculations were repeated.

The inventory was designed to provide statistically reliable statewide estimates. From a statistical perspective, adequacy of an inventory would be assessed in terms of precision levels for the most important estimates. Expressed as standard errors of the estimates, precision refers to the consistency of the estimate if repeated sampling of the population was to take place. The standard errors for the statewide inventory estimates are available upon request.

2 As used in this study, "silviculture" refers to vegetative manipulation for such purposes as timber production, recreation, aesthetics, hazard tree reduction, sugarbush management and wildlife habitat improvement.

3 Status of Timber Harvesting in Vermont

Introduction

Before presenting the results of the impact analyses, it is necessary to first provide a contextural setting by describing the status of timber harvesting in the state. This was the objective of the inventory portion of the study. By understanding the level and extent of harvesting activity, interpretations of the relative importance of the impacts are possible. There are far more possible analyses of the inventory data than are presented in this section. Those that are included provide a reasonable overview of timber harvesting as we found it.

The 78 sampled harvesting operations ranged in size from 2 to 1,108 acres. The average size of operation was 93 acres. Assuming that the sample was representative of the population of harvesting operations, we estimate that during the 12-month period some type of harvesting activity took place on 70,122 acres of timberland (754 operations with an average size of 93 acres). Frieswyck and Malley (1985) estimated that there was 4,422,100 acres of timberland in the state. Therefore, our estimated level of harvesting activity implies that annually nearly 1.6% of the state's timberland experiences some type of harvesting activity.

To characterize the level and extent of harvesting in the state, three general types of statistics are reported according to various operation characteristics. The *percentage of operations* presents the relative frequency that a particular characteristic occurred on a per operation basis. *Average size of operation* provides an estimate of the average acreage for the operations that are associated with the listed characteristics. The third statistic is the *statewide percentage of harvested area* for the various operation characteristics. Based on the average size and percentage of operation statistics, this figure estimates the percentage of the 70,122 harvested acres that can be linked with each of the characteristics. Unless otherwise stated, these three statistics are based on the evaluation of all 78 sample observations.

General Characteristics

The southern forest region of Vermont as defined by Frieswyck and Malley (1985) includes Addison, Bennington, Chittenden, Rutland, Windham, and Windsor counties. The northern region is made up of the remaining eight counties. There were nearly equal numbers of operations in the northern region as in the southern region. The average size of operation in the North was more than 2.5 times the average size for the South (137 acres versus 53 acres).

Fifteen percent of the operations took place on public land, with the largest of these operations being found on state land (134 acres) (Table 3-1). Harvesting on state lands represented 11% of the statewide harvested area. Seventy-three percent of operations occurred on timberland owned by the non-industrial (i.e., not forest products industry) private forest sector (NIPF) and these operations averaged 51 acres in size. While only 12% of the operations were on forest industry land, because of their relatively large average size (369 acres), this represents 48% of the statewide harvested area. There was only a slight difference in average operation size between the public and private aggregate categories.

Table 3-1. Operation area and frequency, and statewide percentage of harvested area by type of land ownership for timber harvesting operations in Vermont in 1988.

Ownership	Average size of operation (acres)	Percentage of operations	Statewide percentage of harvested area
Public			
State	134	8	11
Federal	54	5	3
Municipal	6	2	<1
Total public	86	15	14
Private			
NIPF	51	73	40
Industry	369	12	48
Total private	94	85	86
Total	93	100	100

Timber harvesting operations on private land that was enrolled in Vermont's Use Value Appraisal (UVA) program represented 40% of all operations (Table 3-2). With an average harvested acreage of 74 acres, nearly one-third of the statewide harvested area was on UVA lands. Thirty-seven percent of operations were on private lands that were of sufficient size to qualify for UVA, but were not enrolled in the program. The average harvested area for these lands (155 acres) was nearly twice the size for UVA harvests and therefore represented more than one-half of the statewide harvested area.

The stated primary objective for 83% of the operations was silviculture, or more generally timber management (Table 3-3). The average size for these

Table 3-2. Operation area and frequency, and statewide percentage of harvested area by Use Value Appraisal program eligibility and enrollment status for timber harvesting operations in Vermont in 1988.

Ownership/UVA status	Average size of operation (acres)	Percentage of operations	Statewide percentage of harvested area
Public ownership	86	15	14
Private ownership	94	85	86
Enrolled in UVA	74	40	32
Eligible but not enrolled in UVA	135	37	54
Not eligible due to tract size	6	8	<1
Total	93	100	100

operations was 103 acres and thus represented 92% of the statewide harvested area. Land development was the stated primary objective for 9% of the operations, but because the average size for such harvests was only 7 acres, this amounted to only 1% of the statewide harvested area. The survey did not include any operations that had stated objectives of land clearing for agricultural purposes. We feel certain some harvesting took place with this as the primary objective, but that it was sufficiently uncommon to have represented only a nominal level of activity.

Table 3-3. Operation area and frequency, and statewide percentage of harvested area by primary harvesting objective for timber harvesting operations in Vermont in 1988.

Stated harvesting objective	Average size of operation (acres)	Percentage of operations	Statewide percentage of harvested area
Silvicultural	103	83	92
Development	7	9	1
Other/unknown	88	8	7

Seventy-two percent of the operations, or 90% of the statewide harvested area, utilized a mix of silvicultural methods on the individual operations (Table 3-4). Only 1% of statewide harvested area occurred on operations that could be characterized as only clearcutting. Pure individual tree selection cutting took place on 15% of operations, but since the average size for these selections was only 35 acres, this represents only 6% of the statewide harvested area. If the mixed silviculture operations were subdivided according to method and then combined with the single method operations, clearcutting and individual tree selection represented 8 and 42% of the statewide harvested area, respectively (Table 3-5). From this perspective, the average area per clearcut was 32 acres. Regeneration operations such as shelterwood, and seed tree cuts that removed between 25 and 74% of the overstory represented 44% of statewide harvested area.

Table 3-4. Operation area and frequency, and statewide percentage of harvested area by silvicultural method for timber harvesting operations that used a single silvicultural method in Vermont in 1988.

Silvicultural method	Average size of operation (acres)	Percentage of operations	Statewide percentage of harvested area
Individual tree selection	35	15	6
Group selection		0	0
Regeneration (shelterwood, seed tree)	68	4	3
Strip cutting		0	0
Clearcutting	15	9	1
Multiple methods per operations	116	72	90

Table 3-5. Operation area and frequency, and statewide percentage of harvested area by silvicultural method for timber harvesting operations in Vermont in 1988.

Silvicultural method	Average size of operation where method found (acres)	Average size of area per operation under method (acres)	Percentage of operations	Statewide percentage of harvested area
Individual tree selection	106	49	81	42
Group selection	91	16	36	6
Regeneration (shelter wood, seed tree)	125	65	63	44
Strip cutting	100	10	1	<1
Clearcutting	92	32	23	8

Professional Assistance and Contracts

Professional assistance for planning and conducting timber harvesting operations is usually provided by professional foresters, and may occasionally be complimented by a wildlife biologist, archaeologist, landscape architect, or other specialist. For the purposes of assessing professional assistance, the interviews for this study mentioned only professional foresters and wildlife biologists. Twenty-three percent of operations, but only 12% of the statewide harvested area, were conducted without known forester involvement (Table 3-6). Where there was known forester involvement, the operations were more than twice the size as those without foresters (107 acres versus 48 acres).

In all cases where a forester was involved, the forester did a general reconnaissance of the area. However, the level of participation in other operational activities, ranging from preparing a management plan to supervising the operation closeout, was varied. In general, for the larger operations, the forester was involved in more activities. The least frequent activity for forester involve-

Table 3-6. Operation area and frequency, and statewide percentage of harvested area by professional forester involvement and type of involvement for timber harvesting operations in Vermont in 1988.

Professional forester involvement	Average size of operation (acres)	Percentage of operations	Statewide percentage of harvested area
No (or unknown) involvement by professional forester	48	23	12
Professional forester involved in harvesting operation	107	77	88
Reconnaissance	107 (0)	77 (0)	88 (0)
Management plan	126 (56)	56 (21)	76 (12)
Marking timber	107 (100)	71 (6)	82 (6)
Contract negotiation	120 (63)	59 (18)	76 (12)
Road/trail layout	116 (84)	51 (26)	64 (24)
Landing location	120 (67)	58 (19)	75 (13)
Closeout supervision	125 (47)	59 (18)	79 (9)

Figures in parentheses represent those cases where a professional forester was involved in the overall harvesting operation, but not in the specific activity listed.

ment was the design and layout of the harvesting roads and trails (51% of operations, representing 64% of statewide harvested area). For 13% of the operations, a wildlife biologist was involved along with a forester. In only 1% of the operations was a biologist involved but not a forester.

When there was a forester involved, the forester was most often a consulting forester (32% of operations) (Table 3-7). There was a wide array of average sizes of operations for the different types of foresters, ranging from an average of 19 acres per operation for county foresters to 269 acres for industrial foresters. Either operating on forest industry land or on other private holdings, industrial foresters were involved in operations amounting to 52% of the statewide harvested area.

Table 3-7. Operation area and frequency, and statewide percentage of harvested area by type of professional forester involved in Vermont timber harvesting operations in 1988.

Type of forester	Average size of operation (acres)	Percentage of operations	Statewide percentage of harvested area
Federal	54	5	3
State lands	137	8	11
County	19	10	2
Consulting	52	32	18
Industrial	269	18	52
Other	45	4	2
Total forester involvement	107	77	88
No/unknown forester involvement	48	23	12

In some cases, it was unknown whether or not a formal written contract existed for the timber harvesting operation. However, most operations (71%) did have an associated contract (Table 3-8). The average size of operations with a contract was 118 acres, as opposed to an average of 33 acres where there was not a known contract. Clearly, the larger the operation, the greater the likelihood for a contract. Operations for 90% of the statewide harvested area involved contracts. Where there were contracts, the included provisions were quite variable. Operations for 12% of the statewide harvested area had contracts, but with no special provisions regarding potentially impacted resources. Eighty-two percent of the contracts had provisions for water quality and 78% had some conditions that addressed aesthetic issues. Owing to the differing sizes of the operations, those with contract provisions for water quality, aesthetics, and wildlife habitat represented 77%, 47%, and 45% of statewide harvested area, respectively.

Table 3-8. Operation area and frequency, and statewide percentage of harvested area by type of provisions in harvesting contracts for timber harvesting operations in in Vermont 1988.

Type of contract provision	Average size of operation (acres)	Percentage of operations	Statewide percentage of harvested area
Aesthetic	79	55	47
Archaeologic/historic	63	8	5
Threatened/endangered species	19	4	1
Water quality	123	58	77
Wildlife	248	17	45
No special provisions	171	6	12
Total with contract	118	71	90
No/unknown contract	33	29	10

Operational Characteristics

From an operational perspective, the median duration of a timber harvest was from one to three months (Table 3-9). Seventy-five percent of operations took six months or less to complete. For a given duration, the operations in the northern region tended to be substantially larger than those in the southern region.

As the size of the operation became larger, the number of log landings per operation increased from one to an observed maximum of three (Table 3-10). While the size of the landings ranged from 0.1 to 1.4 acres with a mean of 0.3 acres, there was no apparent tendency to increase the size of the landing(s) with the operation size.

The method of designating trees for removal is in part a function of the silvicultural methods used for the harvesting operation. Acknowledging the mix of silvicultural methods that characterized most operations, there was a single

Table 3-9. Operation area by region, and area and frequency statewide by duration of timber harvesting operation in Vermont in 1988.

Duration (months)	Average size of operations (acres) North	South	Statewide	Percentage of operations statewide
<1	7	13	12	21
1 - 3	149	33	87	33
3+ - 6	195	38	146	21
6+ - 9	129	76	119	6
9+	163	159	160	14
Unknown	38	30	36	5
Total	137	53	93	100

stated primary method used to designate trees for harvest for each operations. The most common primary tree designation method was the marking of individual trees (52% of operations, an average size of operation of 70 acres, and

Table 3-10. Operation area and frequency by number of log landings per timber harvesting operation in Vermont in 1988.

Number of landings	Average size of operation (acres)	Percentage of operations
1	47	53
2	83	29
3	244	18

Average size of an individual log landing was 0.3 acres. Individual landings ranged in size from 0.1 to 1.4 acres.

39% of total statewide harvest area) (Table 3-11). While diameter limit selection was much less common (8% of operations), the larger average harvest area meant that it accounted for 37% of the total statewide harvested acres. Fifteen percent of statewide harvested area was harvested using logger's-choice selection (19% of operations with an average operation size of 72 acres). (Analyses showed that one-third of the logger's-choice operations had a professional forester involved in the operation.)

Table 3-11. Operation area and frequency, and statewide percentage of harvested area by primary method of designating trees for removal for timber harvesting operations in in Vermont 1988.

Designation method	Average size of operation (acres)	Percentage of operations	Statewide percentage of harvested area
Diameter limit	443	8	37
Individual trees/rows marked	70	52	39
Logger's choice	72	19	15
Perimeter marked	15	4	1
Other methods	47	17	8
Total	93	100	100

Clearly, the preferred type of skidding equipment was the rubber-tired skidder, apparently operating on all but the smaller operations and accounting for 92% of all operations (Table 3-12). Tracked skidders operated on 24% of operations. With the smallest average operation size, horse skidding was employed on only 3% of operations.

Table 3-12. Operation area and frequency by type of skidding equipment used on timber harvesting operations in Vermont in 1988.

Skidding equipment (singly or in combination)	Average size of operation (acres)	Percentage of operations
Rubber-tired skidder	100 (12)	92 (8)
Tracked skidder	83 (96)	24 (76)
Horse	11 (95)	3 (97)
Other	145 (91)	5 (95)

Figures in parentheses represent operations where the specified equipment was either not used or it was unknown if it was used.

Tree length skidding, either by itself or in combination with other methods, was the preferred skidding method (occurring on a total of 79% of operations and accounting for approximately 74% of the total statewide harvested area) (Table 3-13). Not surprisingly, wholetree skidding was employed less often (a total of 10% of operations), but these operations were of sufficient size so as to have represented approximately 36% of the statewide harvested area.

Table 3-13. Operation area and frequency, and statewide percentage of harvested area by skidding method(s) for timber harvesting operations in Vermont in 1988.

Skidding method(s)	Average size of operation (acres)	Percentage of operations	Statewide percentage of harvested area
Only log length	63	12	8
Only tree length	90	46	45
Only wholetree	243	6	16
Log and tree length	30	29	9
Tree length and wholetree	708	3	20
All three methods	10	1	<1
Unknown	55	3	2
Total	93	100	100

It was not possible to reliably estimate the total volume or value of products removed for the timber harvesting operations. However, it was possible to identify the types of products removed (Table 3-14). Most harvesting operations removed a wide mix of products ranging from fuelwood to veneer logs. In general, the larger the operation, the greater the mix. Ninety-five percent of operations removed sawtimber, 70% removed pulpwood, and 72% removed firewood. The capital intensive harvesting operations that lead to chip production were found on 13% of operations and averaged 284 acres in size. Opera-

Table 3-14. Operation area and frequency by type of product removed for timber harvesting operations in Vermont in 1988.

Type of product (removed singly or in combination)	Average size of operation (acres)	Percentage of operations
Firewood	66	72
Pulpwood	111	70
Hardwood	174	40
Softwood	114	63
Sawtimber	98	95
Hardwood	117	76
Softwood	105	83
Veneer	250	23
Chips	284	13

tions that removed veneer logs as separately marketed products were also rather large in size, with an average size of 250 acres.

4 AESTHETIC VALUES

Introduction

This section of the study examines the visual impacts of timber harvesting operations from the point of view of public and quasi-public use areas. The study indicates that the majority of harvesting operations in Vermont have a minimal impact on the visual quality of the landscape. Nevertheless, severe impacts do occur. These operations demonstrate some distinct problem areas which will be discussed below. Recommendations are made concerning ways to reduce impacts, and an appropriate role for public administrators to encourage well designed harvests. One of the most interesting results of the study is that, if properly used, clearcutting can produce positive results. Furthermore, in certain cases clearcutting may actually be visually preferable to some partial cutting alternatives.

Assumptions about Public Preference

There is a common notion that "beauty is in the eye of the beholder." While this may be true in viewing works of art and the object of one's affections, it is far less true in the perception of landscape beauty. In fact, a considerable body of research conducted over the past 20 years or more shows that people, especially of similar cultural groups, share to a great degree their preferences for certain landscape characteristics. Public reactions to timber harvesting operations have been a particular focus of much of the research, and the results have shown strong public preferences for certain kinds of forests and strong dislikes for certain harvesting effects. This and other research has led to the development of visual management systems for many of the larger holdings of public and private forest lands in the United States. These systems allow managers to predict visual impacts and to plan timber harvests to minimize impacts in visually sensitive areas.

A review of various studies of public perceptions of forest aesthetics led to some basic assumptions about the kinds of information needed to evaluate forest practices in Vermont. Some of the public preferences that are consistently revealed in these studies are as follows:

- slash is nearly always viewed negatively (Rader 1978, Benson and Ullrich 1981, Schroeder and Daniel 1981);
- exposed earth is generally viewed negatively, especially in the context of forests (Benson and Ullrich 1981);
- managed (thinned) stands are often preferred over unmanaged stands, except for old age stands (Brush 1981, Schroeder and Daniel 1981);
- dense thickets of small trees are viewed less positively than are stands of large trees with more spacing between them (Brush 1981, Schroeder and Daniel 1981);
- there is a great diversity of opinion over clearcutting: some view it positively, others negatively (Langenau et al. 1980);
- small openings (4-20 acres) are often viewed as positive, especially if a green groundcover such as grasses or forbs exists (Brush 1981); and
- dead or dying vegetation is viewed negatively (Buhyoff and Leuschner 1978).

Design of the Survey

The survey instrument was designed to assess several visual attributes associated with timber harvesting operations in Vermont:

- to what extent are harvesting operations visible to important public outdoor use areas;
- to what extent do these operations occur in the foreground of or adjacent to important public viewing areas;
- to what extent are the cuts seen at a distance;
- how significant are the positive and negative impacts of harvesting operations; and
- what specific attributes of the timber harvesting cause positive, negative, or no impacts.

While most timber harvesting operations have an impact on at least one person somewhere, this study sought to identify the extent to which timber harvesting produced significant visual impacts on the public in general. For the purposes of this study, a harvesting operation was evaluated for visual impacts only if it was visible from a public or quasi-public outdoor area. The outdoor area must receive considerable public use (more than a few people) or have recreational or scenic values. These areas were defined as paved public roadways, public recreation areas, designated trails (hiking, bicycle, bridal, cross-country skiing, and snowmobile), streams (with watersheds greater than 10 square miles), lakes and ponds (greater than 25 acres in size), designated natural areas, and designated scenic areas.

Unpaved roads were not included as viewpoints in order to simplify data collection and because they do not carry the volumes of regional traffic which paved public roadways do. However, the notes taken during data collection indicated that the results would not have been appreciably different had gravel roads been included. Smaller ponds and streams were not included for similar reasons.

If the timber harvesting operation was visible from one of the areas noted above (including selection cuts that were only visible to the trained eye) then a potential aesthetic impact was assumed and detailed data were collected. The collected data were the basis for the evaluation of the nature and severity of the impact. In some cases the cut was seen from two or more locations or along a view corridor such as a road or trail. In the latter case, views were evaluated at several points along the view corridor, and the overall evaluation of impacts was based upon only those points of greatest impact. For each evaluation point, both the length of the view corridor and the area of the harvest that was visible were recorded. For each viewing location, photographs were taken of the associated harvesting operation.

For operations that could be seen in the foreground of, or immediately adjacent to, viewing areas, information was collected concerning (1) the visual characteristics of the exposed harvest area (size of openings, edge transition, edge configuration, horizon line, stumps, slash and debris, and exposed earth); (2) the apparent residual stand (size, health, and spacing of trees); (3) any associated forest roads (size, alignment, cut and fill slopes, and public access); and (4) any related wetlands (buffer, slash, and access).

If the view of the operation was not immediately adjacent to the operation, it was evaluated as a background view. Details of the harvest, such as slash and exposed earth, become less significant as distance from the viewer increases, while the characteristics of size and shape of the cut and its contrast or conformance with surrounding land use patterns become more significant. Edge transition and the treatment of the horizon line (ridge) were also important considerations.

In evaluating the overall impacts of the distant views, the field investigator used two ranking systems. One was a general rating system that ranked the overall operation as having an improved effect, no impact, a minimal impact, a moderate impact, or a severe impact. The second rating system was the USDA Forest Service's system for describing visual management objectives. This second system had the advantage of being very well defined, and represented an approach with which the data collector was very familiar. The following terms were used for this portion of the study (see USDA Forest Service 1974 for a more detailed explanation of these terms).

Enhancement: operation results in improvements to the visual quality of the landscape by adding diversity (through plantings or small openings, especially those that appeared similar to agricultural openings) or by opening up positive views.

Preservation: operation represents no discernable change to the forest landscape from viewing areas (this definition varies from the Forest Service's approach). This rating applied only to minor selection cuts.

Retention: operation is barely discernable to an observer and would have very short term impacts.

Partial Retention: results of harvesting activities are visually subordinate to the surrounding landscape (i.e., appear as a very small part of the total view) and appear to fit reasonably well into the landscape (i.e., shape, size, and edge of cuts are relatively unobtrusive). Duration of impacts is short (one to two years).

Modification: harvesting operation may be visually dominant (i.e., quite noticeable), but the cut does not strongly contrast with surrounding landscape, for example, moderate sized cut on hillside that does not break horizon line and edges are feathered (natural transitions from small shrubs to large trees, or low branching trees along the edges).

Maximum Modification: an operation which is visually dominant, but has avoided strongly negative elements. For example, a rather large clearcut that has been designed to mimic an abandoned agricultural field, or avoids other negative features such as an abrupt edge exposing tall tree trunks, distinct horizon line cut, or leaning and poor quality trees scattered over the cut area.

Unacceptable Modification: the harvesting operation results in a view that is highly obtrusive and unsightly and constrasts strongly with the surrounding landscape.

Analysis and Results

In examining visual impacts, it is necessary to look at the individual characteristics of each harvest operation and its context. In addition to the recorded data, slides and notes taken by the data collector were enormously helpful in making a final determination as to the severity of impacts of each harvest. Several sites were also visited by other members of the study team.

Overall impact ratings were determined by examining the visual characteristics of each cut: the type of cut, the nature of the area from which it could be seen, the area of the cut that was visible, and the number of places from which it was visible.

Harvests that were seen in the foreground or adjacent to a public viewing area were examined for detailed characteristics of the harvest, the visual quality of the residual stand, the design of roads, and the visual impacts on wetlands.

A total of 22 attributes were examined and rated as having a low, moderate, or high visual impact. A high impact rating in only one of the 22 attributes did not necessarily imply that the overall impact of the harvest was severe. Severe impacts generally result from a combination of problems.

Operations were given a severe overall rating if four or more of the possible 22 attributes were individually judged as having a high visual impact. Projects with three highly rated visual characteristics were given an overall moderate-to-severe rating; those in which one or two characteristics had a high impact were assigned an overall moderate rating; and those with only moderate to low ratings on all factors were rated as having only slight impacts. One exception was a small clearcut along historic boundaries which opened up distant views and was given an improved to minimal impact rating.

Of the 78 timber harvesting operations studied, 46 (59%) could be seen from significant public viewing areas (paved roads, trails, streams, ponds, or natural areas). Forty-five percent of the operations were immediately adjacent to a viewing location and 47 percent were visable from a distance. Some operations could be seen from more than one area and therefore could represent viewing from both an adjacent location and a distant location. Of those that were visible, 34 (43% of the total) had a minimal or no negative impact (5 of these operations improved the visual quality of the forest); 9 (12%) had moderate impacts; 1 (1%) operation was rated moderate to severe; and 2 (3%) were rated as having severe impacts (Table 4-1).

Table 4-1. Visual impact of 78 timber harvesting operations in Vermont in 1988.

	Frequency (percentage)					
Perspective	Not seen	Improved	None-slight	Moderate	Moderate-severe	Severe
Adjacent to view location	43 (55)	3 (4)	17 (21)	12 (15)	2 (3)	1 (1)
Background to view location	42 (53)	2 (3)	24 (31)	7 (9)	1 (1)	2 (3)
Overall combined assessment	32 (41)	5 (6)	29 (37)	9 (12)	1 (1)	2 (3)

The 34 operations that had minimal negative, no, or improved impacts were in many cases primarily selection cuts, or cuts that were hidden from public view by a vegetative buffer. Landing areas were hidden or appeared as grassy openings free of slash and debris (Figure 4-1). In a few cases, the cuts were clearcuts that created openings that looked very much like abandoned agricultural fields. These small clearcuts, generally less than ten acres in size, fit well into the landscape, and in some cases opened up a distant view or added visual diversity to the landscape. Abrupt edges lined with tall spindly trees were not visible in these clearcuts. In most cases this visual problem was avoided by cutting along historic boundaries such as a fenceline or intermittent stream (Figure 4-2).

Figure 4–1. (Right) This log landing represents a minimal negative visual impact because it appears as a grassy opening free of slash and debris.

Figure 4–2. (Below) Example of enhanced or minimal negative visual impact created by harvesting along historic boundaries.

The nine operations that were rated as having moderate impacts were characterized by not more than two of the following attributes: larger openings (greater than eight acres) that did not dominate the landscape; a small area where abrupt edge transitions occurred and where tall spindly tree trunks were noticeable; or landing areas that were visible and had not been reseeded, or some slash and debris were evident, or some slash was visible from a public viewing point. To receive a moderate rating none of these attributes could dominate the view or could be seen only briefly (Figure 4-3).

The one operation that was rated moderate to severe was primarily a selection cut, but the remainder of the cut (about 30 acres in size) was located on a prominent mountainside which was visible from many locations (though never immediately adjacent to the viewer). Moreover, the horizon line (top of the hill) had been partially cut making it far more noticeable (Figure 4-4).

The two operations that were rated as severe shared similar characteristics. Both were "economic" clearcuts in which the valuable timber was removed leaving spindly, poor quality, often windblown trees sparsely scattered over a large cut area (about 30-40 acres were visible in each case). Both were located on highly visible hillsides from state roads, and in both cases the horizon line (hilltop) had been heavily cut leaving only poor quality, windblown trees. In one case the landing area was inadequately screened and covered with debris. Both operations occurred in the northern region on privately owned parcels that were

Figure 4–3. (Above) This operation received a moderate rating because the cut area was visible only for a short distance along a snowmobile trail.

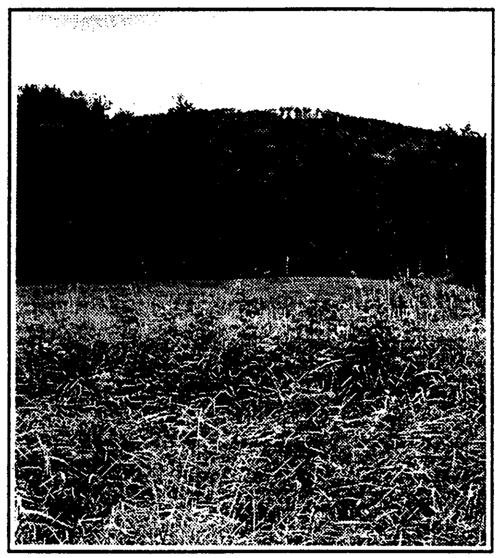


Figure 4–4. (Right) Example of moderate to severe negative visual impact with the partially cut horizon line drawing attention to the operation.

Figure 4–5. (Below) Example of severe negative visual impact created by heavily cutting the horizon line on a highly visible hillside.

not enrolled in UVA, and neither cut benefited from the involvement of a professional forester (Figure 4-5).

It should be noted that in most cases the impacts will be short term. Operations with only minimal impacts will hardly be noticeable in another year. Those with moderate impacts may take two to five years before they will be difficult for an untrained observer to see. The more severe cuts may take from five to ten years to recover.

Other results show that where problems occurred, they were usually due to size of cut, type of cut, cutting on the horizon line, abrupt edge transitions, poorly reclaimed landing areas, and slash. Few of the operations had left large stumps or exposed earth in public viewing locations, and slash appeared to be a minor problem in most areas (Table 4-2). None of the operations had roads that appeared inappropriately large or poorly aligned (long straight stretches or overly steep grades). Although visual impacts along local gravel roads were not officially tallied, the notes indicated that the results would have been very much the same.

Table 4-2. Visual impacts of slash for 78 timber harvesting operations in Vermont in 1988.

Impact	Frequency	Percentage
Non-existent	21	27
Not seen	43	55
Close to ground; > 200 feet from viewer; probably disappear from view within 2 years	11	14
Left where it falls, large limbs and trunks dominate the scene	3	4

One positive result of these harvesting operations was that new public access had been created for walking, skiing, snowmobiling, and hunting in 43% of the operations assessed for aesthetic impacts. Moreover, there was evidence of actual use in many cases. A negative aspect of the new public access was that trash, not directly related to the harvesting operation, had been left on some landing areas near public roads.

All operations observed on public lands had either no negative visual impacts or at worse moderate impacts. The privately owned land experienced the full range of ratings, from improved to severe (Table 4-3). The ratings conducted on land owned by timber industries generally varied from slight to moderate impacts, with one operation having a moderate to severe rating. On the other hand, innovative techniques for reducing visual impacts were evident on some timber industry land. These techniques included creating dense buffers several years prior to cutting and carefully positioning landings out of view.

Table 4-3. Distribution of visual impacts by ownership type for 78 timber harvesting operations in Vermont in 1988.

	Frequency (percentage)					
Ownership	Not seen	Improved	None-slight	Moderate	Moderate-severe	Severe
Public	4 (5)	1 (1)	5 (6)	2 (3)	0	0
Private	28 (36)	4 (5)	24 (31)	7 (9)	1 (1)	2 (3)

Table 4-4. Distribution of visual impacts by forester involvement in 78 timber harvesting operations in Vermont in 1988.

Involvement	Frequency (percentage) Not seen	Improved	None-slight	Moderate	Moderate-severe	Severe
Forester	26 (33)	3 (4)	24 (31)	6 (8)	1 (1)	0
No/unknown forester	6 (8)	2 (3)	5 (6)	3 (4)	0	2 (3)

Foresters were involved in the majority of the cuts that were rated more positively, but were not involved in the cuts that were most severe negatively (Table 4-4). Landowners who were enrolled in the Use Value Appraisal program were less likely to produce the most severe visual impacts in managing their forests (Table 4-5). On the other hand, an almost equal number of

Table 4-5. Distribution of visual impacts by landowner enrollment in Use Value Appraisal (UVA) program for 78 timber harvesting operations in Vermont in 1988.

Status	Frequency (percentage) Not seen	Improved	None-slight	Moderate	Moderate-severe	Severe
UVA	11 (14)	2 (3)	14 (18)	3 (4)	1 (1)	0
Non-UVA	14 (18)	2 (3)	9 (11)	4 (5)	0	2 (3)
Not eligible	7 (9)	1 (1)	6 (8)	2 (3)	0	0

landowners not enrolled in the program were conducting harvests with slight impacts or improved results. More severe impacts occurred in the northern part of the state (Table 4-6).

Table 4-6. Distribution of visual impacts by region for 78 timber harvesting operations in Vermont in 1988.

Region	Frequency (percentage) Not seen	Improved	None-slight	Moderate	Moderate-severe	Severe
Southern Vermont	21 (27)	3 (4)	14 (18)	3 (4)	0	0
Northern Vermont	11 (14)	2 (3)	15 (19)	6 (8)	1 (1)	2 (3)

In conclusion, although a few timber harvesting operations that were poorly executed loom large in the public eye, overall the visual impacts of timber harvesting are minimal, and in some cases, the effects are positive. In fact, there appeared to be an attempt to reduce the visual impacts in almost every operation that was observed. In some cases the attempts were far from adequate, in others the measures taken were highly effective. Every operation preserved some vegetative buffer between public roadways and the timber harvesting area. Slash described as "left where it falls, large trunks and limbs dominate the scene" was a problem in only three of the operations, and in these, only a small area was visible to the public. In most cases slash was dispersed or otherwise disposed of. None of the operations showed evidence of visually inappropriate road design, and in many cases new public access to the forest was created.

Nevertheless, significant visual impacts did occur as a result of harvesting operations. The most serious problems were large economic clearcuts and shelterwood cuts in which spindly, poor quality trees remained scattered over the cut area, and cuts that broke or opened up the horizon line (ridgeline). The first produced an effect that was like a partially shaved beard or a spotty lawn mowing job. The effect was particularly noticeable when it occured on a hillside. Often a vegetative buffer along the roadside was ineffective in such situations. True silvicultural clearcuts in which all trees were removed, especially where the cut followed historic boundaries such as fencelines were generally more visually pleasing as they often appeared as abandoned fields and added diversity to the landscape (Figure 4-6).

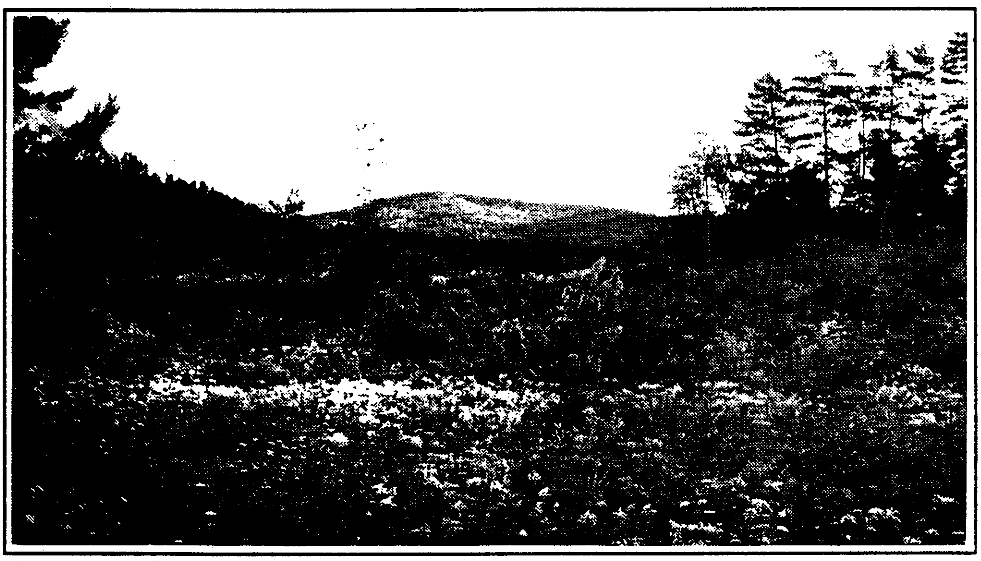


Figure 4–6. Example of a distant view revealed by timber harvesting.

Operations that occur on ridgetops, particularly those that are high enough to be readily seen against the sky, immediately become focal points in the landscape, even when the cuts are relatively small. In these cases, the partially barbered effect described above and abrupt edges are especially noticeable and disturbing. In some cases a more complete job of clearcutting an entire hilltop might be preferable to leaving a few poor quality trees which are frequently windblown and tilting.

Though less of a problem, many operations in which landing areas were located adjacent to public viewing areas could be significantly improved by a more thorough cleanup of the landing area. One problem in chipping operations was that a large layer of chips was sometimes left which acted as mulch and delayed revegetation. Spreading out the chips or covering them with a layer of soil could help speed up the revegetation process. Removing slash and debris from landings also helps. Because landing areas can result in short term visual impacts during the operation, and are frequently used by the public after completion, sometimes with resulting trash, it may be better to set these areas so they are hidden from public roadways.

Recommendations

Although serious visual impacts did occur during and after timber harvesting operations, they did not appear to be frequent enough to warrant a regulatory approach. In almost all cases the impacts were considered short term. Recommendations for minimizing future visual impacts would include the following:

(1) Provide a simple process for identifying areas that will be particularly sensitive to the visual impacts of timber harvesting, i.e., where the public is likely to be affected. An organized program should be initiated to identify areas of statewide and regional visual importance. Because of the widespread value of such a mapping activity, the Planning Division of the Vermont Agency of Natural Resources should assume responsibility for the coordination and conduct of this assessment. The Department of Forests, Parks and Recreation should consider incentives for well designed harvests (see Appendix C for some design guidelines) in these visually sensitive areas that are forested.

(2) The Vermont Department of Forests, Parks and Recreation and the University of Vermont's Extension Service should educate landowners, foresters, and loggers as to how visual impacts can be reduced (some suggested design guidelines are given in Appendix C). Clear, simple, and economically reasonable guidelines should be available to all landowners, foresters, and timber operators. Educational efforts should recognize the differences in harvesting practices in northern and southern Vermont.

(3) Demonstration areas should be developed by the Department of Forests, Parks and Recreation to show ways in which a variety of cutting practices can be done with minimal visual impacts. These cutting practices should include heavy cuts using both clearcutting and shelterwood cutting techniques. Techniques for mitigating severe impacts could be demonstrated on private lands.

5 ARCHAEOLOGICAL RESOURCES

Introduction

Archaeological sites are a key link to understanding Vermont's cultural heritage. It is anticipated that two types of archaeological sites will occur within timber sale areas: historic and prehistoric. Historic archaeological sites dating to the past 250 years can provide significant information about local and regional historical developments and processes, which cannot be obtained from written records alone. For most of the past 10,000-year period since people took up residence throughout Vermont, prehistoric archaeological sites provide the only record of human history and culture.

The value of archaeological sites is recognized during agency reviews of all federally funded or licensed undertakings; such reviews are specifically mandated for all timber sales on USDA Forest Service land. The importance of cultural resources, including archaeological sites, is reflected at the state level by the Vermont Historic Preservation Act of 1975 and Act 250, Criterion 8. Under section 743 of the Vermont Historic Preservation Act, all state agencies, departments, divisions, and commissions are required to "institute procedures to assure that their plans, programs, codes and regulations contribute to the preservation and enhancement of sites, structures and objects of historical, architectural, archaeological or cultural significance."

Archaeological sites are fragile, nonrenewable cultural resources. The significance of a site is determined in part by the artifacts and features that it contains, but even more importantly by the spatial patterns of such artifacts and features. Once such patterns have been disturbed, the recovery of information through archaeological excavation may be extremely difficult. Any type of activity that causes soil disruption during a timber harvesting operation could have a direct adverse effect on any prehistoric or historic site if its integrity is disturbed.

For this portion of the study, the primary focus of the field reviews of 78 timber harvesting operations was to obtain sufficient information to characterize the types and potential significance of the impacts to both prehistoric and historic archaeological resources from such operations.

Analysis and Results

Unlike some other evaluated resources, archaeological sites of either the historic or prehistoric past are unlikely to experience any positive effects from timber harvesting operations. Aside from any structural remains, historic archaeological deposits surrounding a structure, as well as nearly all prehistoric artifacts and features remaining at a site, are likely to be buried at very shallow depths, and any surface disruption or appreciable erosion may cause significant and permanent damage to a site's integrity. At best, sites will be avoided. At worst, they will be completely obliterated. Because a detailed evaluation of disturbance at any archaeological site would involve considerable subsurface testing and because the available time for the evaluation of any given operation was very limited, we can offer only a preliminary evaluation of potential disturbance.

Historic Archaeological Resources

Various categories of information were collected with respect to historic archaeological sites in order to address three questions. First, do historic sites exist within areas where timber harvesting operations are conducted? Second, if historic sites do exist, what types of sites are likely to be encountered and with what frequency? Third, what is the general nature and extent of site disturbance produced by timber harvesting activities?

Based on recognized site types and settlement patterns that are characteristic of Vermont's historic past, the most commonly encountered historic period sites (ca. 1740-1930's) in any geographical area are likely to be either late eighteenth, nineteenth, or early twentieth century residences/farmsteads or small industrial sites such as sawmills or gristmills. Other types of sites may exist in lower frequencies and may range from small family cemeteries, charcoal kilns, lime kilns, or sugar houses to larger Civilian Conservation Corps camps, mining complexes, old logging camps, or small rail heads. Except for perhaps the cemeteries or other bounded "activity areas," it is essential to recognize that historic archaeological sites are not defined solely on the basis of structural remains. At a farmstead, for example, site components or features may consist of the house foundation, surrounding yard where many domestic and farm related activities occurred, associated remains of outbuildings (barns, sheds, wells, privies), pens, refuse disposal areas, and a much larger field pattern which may be identified by stone walls, tree lines, and farm roads.

Many highly visible structural remains, as well as many historic features and deposits that are not easily recognized, are distributed across the Vermont landscape. Due to a number of constraints, it was not feasible to compile an exhaustive inventory during the course of this study. However, information could be collected to address two issues. First, we wanted to identify as many sites as possible given the limited field time available. Second, we wished to arrive at a first approximation of the types and relative frequencies of historic features that are likely to be encountered. This is important because all components of an historic site do not possess the same informational value. Rather, on any relative scale that measures archaeological significance, such elements as stone walls or farm roads would rank considerably below residential or industrial complexes that contain structural remains and deposits associated with one or more activity areas.

Analysis

The identification of historic sites in this study relied on the recognition of the more visible features that might be expected to occur, but also included those feature types that are likely to be associated with significant archaeological deposits. Eight categories of features were defined. These features include: house foundations or cellar depressions, outbuilding foundations or depressions, dams and mill foundations, pens in the vicinity of residential areas, rock alignments or depressions of unknown origin, stone walls, and shacks (collapsed or otherwise). An eighth category ("other") was included to cover such things as sugar arches, cemeteries, charcoal kilns, or features that could not be specifically identified as to function.

While it is clear that a variety of historic features may be present throughout Vermont where timber harvesting activities are likely to be undertaken, of greater concern is the evaulation of the potential effects that harvesting may have on such archaeological resources. As noted previously, the significance of a site is determined in part by the artifacts and features that it contains, but also by the spatial patterns of such artifacts and features. Once such patterns have been disturbed, the recovery of information through archaeological excavation may be extremely difficult. From this point of view, a timber harvesting operation will have a direct adverse effect if the integrity of all or part of any site is disturbed.

For each historic site identified, the potential extent of impact and the contributing causes were recorded if possible. Disruption of sites may be produced by a number of activities, but the more obvious or visible activities are likely to be the construction of truck roads, the use of skidder trails, the creation of landings, and general site erosion or substantial rutting from equipment operation. Although many foundations and stone walls may still be partially visible, associated elements at a site are likely to be buried, albeit at fairly shallow depths, and can be detected only through subsurface testing. In terms of impact assessments related to this study, this difference in visibility limits the reliability of the inferences that can be drawn. Without subsurface testing, some impacts can only be inferred, not demonstrated. Therefore, observations at historic sites were made at two levels. The first involves observations about visible features such as foundations. For each structural component, the observer recorded whether it had been breached, filled or rearranged, or avoided. The second involves observations about areas surrounding structural remains where other elements of the site may be present, but where little surface evidence is likely to be observed. As a rough measure of the potential severity of impact, ground disturbance surrounding all structural features was recorded in three categories: "at or within 20 feet," "within 20 to 100 feet," or "not within 100 feet."

Results

Within the sample population of 78 operations, historic structures or related features were observed in 54 (69%) (Table 5-1). The total number of

Table 5-1. Observed historic features in 78 timber harvesting operations in Vermont in 1988.

Type of feature observed	Frequency of observations	Frequency of harvesting operations (percentage in parentheses)
House foundation/depression	19	13 (17)
Outbuilding foundation/depression	6	6 (4)
Dam or mill foundation	2	2 (3)
Pens in vicinity of residence	2	2 (3)
Rock alignment/depression, unknown origin	2	2 (3)
Stone wall	80	50 (64)
Shack (collapsed or otherwise)	2	2 (3)
Other	10	10 (13)
All categories combined	123	54 (69)

observations was 123, with a range of zero to seven historic structures or features per operation. Historic sites were encountered within at least one operation in each of the counties. Residential or mill sites were identified in Addison, Bennington, Caledonia, Essex, Lamoille, Rutland, Washington, Windham, and Windsor counties.

At least two historic features were identified in each of the categories. Structural remains (house, outbuilding, and mill foundations) were fairly common, occurring in 20-25% of operations; stone walls dominate the inventory, occurring in 64% of operations. The "other" category included a sugar house, sugaring arch, sugar house foundation, stone pile with masonry, rock pile (possibly old foundation), stone bridge, two stone piles, and a farm dump. Of the operations where features were found, only one feature was generally observed per operation. However, there is some variation in the number of house foundations per operation, ranging from one to three, and in the frequency of encountered stone walls, with the range of observations per operation from one to five. Overall, there appears to be a fairly even distribution of historic features that are likely to be encountered throughout the operations.

The sample of 78 operations represents a stratified random sample of the 754 operations that were identified as having been completed during the one-year period. Thus, estimates of the total population of historic sites or features are probably on the order of nine to ten times those in the sample. Assuming that this sample of operations is representative of the population of operations throughout the state and that the site types exist in roughly equivalent frequencies, then the chance of encountering historic sites is substantial. From this study, more than 250 structural features (houses, outbuildings and mills, but excluding stone walls) and associated archaeological deposits in their immediate area can be predicted to be present within timber harvest areas annually. This represents more than 2,500 harvesting encounters with archaeological structural features (with some features possibly being encountered more than once) within a single decade.

Even these figures are probably low. A number of factors, including the intensity with which the field survey was conducted, the density of vegetational cover, the time of year, weather conditions, and the recognition abilities of the field observer, are likely to have conditioned the survey results. For 69 of the 78 sample operations, the field observer concluded that by the time he was done gathering all of the field measurements, he had actually seen 50% or less of the harvested area (Table 5-2). Furthermore, the majority of the field observations

Table 5-2. Level of observation of historic features in 78 timber harvesting operations in Vermont in 1988.

Level of observation	Frequency (percentage in parentheses)	
	Harvesting operations	Operations containing sites
10%	2 (3)	0 (0)
20%	9 (11)	7 (78)
30%	15 (19)	8 (53)
40%	20 (26)	17 (85)
50%	23 (29)	17 (74)
60-80%	0 (0)	0 (0)
90%	9 (12)	5 (56)
100%	0 (0)	0 (0)
	78 (100)	

were made between June and October when the vegetation was fully leaved, making it harder to spot historic features. During field studies of some timber sale areas in July and August 1988 on the Green Mountain National Forest, the observed site inventory under represented the population of historic sites by nearly 50% when rechecked by the field team in late November after the leaves had fallen (David Lacy, archaeologist, Green Mountain National Forest, personal communication). In addition, no historic maps, documentary sources, or town histories were consulted beforehand to help pinpoint site locations. Because a number of historic sites were undoubtedly missed during this study, the estimated population of historic sites present within harvesting operations each decade must be considered a minimal estimate. A more reasonable approximation of harvesting encounters within a decade may therefore be between 3,000-4,000, exclusive of stone walls.

Based on information derived from the 78 timber harvesting operations, several general inferences can be drawn (Tables 5-3 and 5-4). First, there appears to be a fairly conscious effort on the part of loggers to avoid the visible structural remains at abandoned historic sites. Breaching or rearrangement of house or outbuilding foundation walls was observed in only three of the 25 structures encountered (Table 5-3), and it is unclear in one instance whether the disturbance was caused during the timber harvesting or prior to it. There may be several reasons why foundations are generally avoided, ranging from landowner or logger interest to the difficulty of running harvesting equipment through these depressions. The information collected for this study is insufficient to address this issue.

Table 5-3. Observed level of direct impact to historic features in 78 timber harvesting operations in Vermont in 1988.

Type of historic feature	Total frequency	Extent of observed impact		
		Breached	Filled/rearranged	Avoided
House foundation	19	1	1	17
Outbuilding foundation	6	1	0	5
Dam or mill foundation	2	0	0	2
Pens	2	0	0	2
Rock alignment, unknown	2	0	0	2
Shack	2	0	0	2
Other	10	2	0	8
Stone wall	80	10	20	50

Figure 5-1. Example of a stone wall avoided by the timber harvesting operation.

Second, there seems to be less concern with maintaining the integrity of stone walls along field edges. Thirty of the 80 walls recorded were either breached or otherwise disturbed (Table 5-3). This practice could cause a loss of archaeological data if it were extensive enough to obliterate large sections of a field pattern or where discrete refuse deposits are present adjacent to a wall and near a residential site. For the most part, however, a substantial loss of data is not anticipated (Figure 5-1).

Third, appreciable erosion or rutting caused by logging operations do not appear to be important factors with respect to the maintenance of site integrity. In no instance was evidence of substantial erosion or rutting found within 100 feet of any structural remains (Table 5-4), with the exception of a few stone walls where archaeological deposits are not expected. If this pattern is characteristic of harvesting in general, then the disturbances at historic sites produced by erosion and rutting are not likely to be as significant as they would be under different management practices.

Finally, truck roads, skidder trails, and landings are clearly affecting the integrity of the soil environment in the immediate vicinity of identified structural remains (Table 5-4). For example, a logging road exists within 100 feet of 12 (63%) of the 19 house foundations, a skidder trail exists within 100 feet of 10 (53%) of the house foundations, and a landing is present within 100 feet of 3 (16%) of the house foundations. In nine of these 25 cases, a road, trail, or landing is within less than 20 feet of a foundation. Roads, trails, and landings are also present within close proximity to a number of other identified structural remains. Because buried archaeological deposits are expected to be present in areas surrounding such structural features, there is a strong possibility that some

Table 5-4. Frequencies of proximity of potential impacts to buried archaeological deposits from timber harvesting operations by cause in Vermont in 1988.

Type of historic feature	Truck rd. 1	Truck rd. 2	Truck rd. 3	Skid rd. 1	Skid rd. 2	Skid rd. 3	Landing 1	Landing 2	Landing 3	Erosion 1	Erosion 2	Erosion 3	Rutting 1	Rutting 2	Rutting 3
House foundation (n = 19)	6	6	7	2	8	9	1	2	16	0	0	19	0	0	19
Outbuilding foundation (n = 6)	3	2	1	1	0	5	0	0	6	0	0	6	0	0	6
Dam or mill foundation (n = 2)	0	0	2	0	1	1	0	0	2	0	0	2	0	0	3
Rock alignment, unknown (n = 2)	1	0	1	1	0	1	0	0	2	0	0	2	0	0	2
Shack (n = 2)	1	0	1	1	0	1	0	0	2	0	0	2	0	0	2
Other (n = 10)	2	0	8	4	4	2	1	0	9	0	0	10	0	0	10
Pens (n = 2)	2	0	0	0	0	2	0	1	1	0	0	2	0	0	2
Stone wall (n = 80)	23	9	48	46	21	13	17	12	51	0	1	79	5	3	72

Cause and proximity of impact.

Proximity of potentially disruptive activity: 1 = at or within 20 feet, 2 = within 20-100 feet, 3 = greater than 100 feet.

potentially significant historic deposits were disturbed within some of the sampled operations. What cannot be determined from this study, however, is the actual frequency of disruption, because no subsurface testing was conducted to verify the presence or absence of historic deposits. Thus, we can only talk in terms of potential loss of archaeological information. From a broader perspective, the creation of truck roads, skidder trails, and landings poses at least a moderate threat to the preservation of archaeological deposits at historic sites in timber harvesting operations throughout Vermont. Based on the sample frequencies, it is anticipated that potentially significant archaeological deposits surrounding some 850 structures may be disrupted during the next decade.

If roads, landings, or trails are to be used by the public afterwards or reused for adjacent harvesting operations, or if individual parcels are to be harvested more than once, then careful road and trail layout become particularly important. With a layout that is insensitive to archaeological concerns, repeated road and trail use means that some sites or deposits may be disrupted several times.

Prehistoric Archaeological Resources

Analysis

Evaluating impacts to prehistoric sites presents a particular dilemma for such a study as this one. Except for bedrock quarries where chert, quartzite, or quartz was secured as raw material for tool manufacture, all prehistoric sites are buried and exist only as clusters of artifacts and features such as hearths, cooking pits, storage pits, or arrangements of post molds left by houses or shelters. Thus, without conducting a subsurface survey, there is no way to actually document site presence or absence. For this reason, evaluating potential impacts to prehistoric sites can only be done at an inferential level.

Prehistoric sites are known to occur in a wide variety of Vermont's physiographic environments, including mountainous parts within the Green Mountain National Forest. In all geographical areas there is a strong positive correlation between most residential sites and portions of the landscape where there is relatively easy access to a source of water, along terraces or where slopes are 5% or less, and where the aspect is south to west. Although conservative, potential prehistoric areas were identified in the field during this study if they were within 100 feet of a stream, pond, lake, wetland, or obvious relict drainage, had a slope of less than or equal to 5%, and were either flat or had a south to west exposure. For such identified locales, it is assumed that a prehistoric site might be present. Assessing the level of disturbance on these terraces, and hence the level of potential impact to prehistoric cultural deposits that might be present, can be done only at the inferential level. Three categories of disturbance were recorded: obvious disruption or point specific disturbance, limited surface disturbance with occasional depressions, or no disturbance observed.

The one type of prehistoric site that might be easily visible is a quarry site where chert, quartzite, or quartz was extracted as raw material for stone tool manufacture. For this reason, the field observer was asked to identify any prominent exposures of these varieties of bedrock. None were observed.

As with efforts related to the discovery of historic sites, a number of factors are likely to have conditioned the results of this survey, including the intensity with which the survey was conducted, the density of vegetational cover, and the recognition abilities of the observer. Given the limited time involved to survey each operation and the percentage of each operation actually observed (Table 5-2), some potential site areas have undoubtedly gone undetected. In addition, some residential and other functional types of sites may be located in places that are not characterized by the three defining characteristics. Clearly, this approach has produced a data base with some unknown biases, and any inferences that are drawn must be considered minimal estimates. Furthermore, depending upon the depth of the prehistoric deposits and their distributional characteristics (deposits are expected to be located in the top ten inches and artifacts are expected to be clustered within any site), it is likely that site integrity would have been compromised in at least some instances where only limited surface disturbance was recorded.

Results

Potential prehistoric site areas were identified in 17 (22%) of the 78 harvesting operations, in Caledonia, Chittenden, Essex, Lamoille, Orleans, Rutland, Washington, Windham, and Windsor counties.

Of the population of potential site areas, ten are alluvial terraces and seven are outwash terraces (Table 5-5). Within these areas, there appears to be little evidence of major natural disturbance. Pit and mound relief produced by tree throws, which might disrupt the spatial characteristics of archaeological deposits, was not observed in nine of the 17 areas (53%), and only occasional pit and mound relief was observed in seven (41%). In only one case (6%) was extensive natural disturbance evident. Thus, the integrity of archaeological sites on such terraces should be good to excellent.

Table 5-5. Characteristics of potential prehistoric site areas in 78 timber harvesting operations in Vermont in 1988.

Potential prehistoric site number	Type of terrace 1 = outwash 2 = alluvial	Pit/mound relief 1 = none 2 = occasional 3 = extensive	Level of disturbance 1 = obvious 2 = limited 3 = none observed	Harvesting activity 1 = trail/road 2 = landing 3 = both 9 = none
1	2	2	1	1
2	2	1	2	1
3	2	2	2	1
4	1	1	3	3
5	2	2	2	1
6	1	1	3	9
7	2	3	2	1
8	1	2	2	1
9	2	1	2	3
10	2	2	3	3
11	1	1	2	3
12	1	2	3	1
13	1	1	1	1
14	2	2	2	1
15	1	1	2	1
16	2	1	2	3
17	2	1	3	1

Where they exist, it is apparent that these alluvial or outwash terraces are utilized extensively during timber harvesting operations. All but one of the 17 terraces were crossed by either a skidder trail or truck road, or were used as a log landing site. This is not surprising when it is considered that such level and well drained locales have obvious advantages and are consistently used during harvesting operations. For the 17 identified terraces, substantial disturbances were evident in two instances (12%), and limited surface disturbances were observed in ten cases (59%). Thus, some level of disruption was observed at 71% of the potential site areas.

Several trends seem apparent from the sample data. Potential prehistoric site areas are being encountered in timber harvesting operations (22% of this sample). If they exist within an operation, there is a reasonable chance that at least some of the areas will be used during timber harvesting for skidder trails, roads, or landings. If prehistoric sites are present, the integrity of a few sites may have been significantly affected, and the integrity of the majority of sites is likely to have been at least partially compromised.

Without carrying out archaeological surveys to determine if prehistoric sites are actually present, it is impossible to obtain an accurate appraisal of site loss or disruption. However, even taking a conservative approach and assuming that the sample is not grossly underrepresented and that only 25% of the potential site areas observed in the 78 harvesting operations contain sites, four prehistoric sites are likely to have been wholly or partially disrupted. If the sample of operations is representative of the entire population of 754 harvesting operations, then approximately 40 prehistoric sites are likely to have been adversely affected to some extent by harvesting activities. Based on the most liberal estimate where all potential prehistoric site areas in the sample operations contain prehistoric sites, approximately 160 prehistoric sites throughout Vermont are likely to have been adversely affected during the one-year period. Even if a middle estimate of roughly 80 sites per year is adopted, the partial disruption of over 800 prehistoric sites (some may be repeated) can be anticipated in the next decade.

Conclusions

Historic and potential prehistoric sites are clearly present within areas used for timber harvesting operations in all regions of Vermont. If the 754 harvesting operations for a recent 12-month period is accepted as a mean for yearly harvesting activity in Vermont and the trends with respect to archaeological sites in the 78 sample jobs are typical of harvesting in general, then a number of estimates can be made about the potential effects of timber harvesting on archaeological sites during the next decade. First, about 7,500 harvesting operations will occur in the next ten years, ranging in size from a few acres to over 1,000 acres. Approximately 5,190 of these operations will contain some visible evidence of an historic site dating to the past 250 years. Potential prehistoric site areas are likely to be present in at least 1,628 operations. Given the nature of our sample data, these are likely to be minimal estimates.

We can anticipate that at least 1,250 harvesting operations will contain historic residential sites centered around house foundations and that a number of outbuilding foundations will be associated. Since roughly 32% of operations in the sample contained several residential sites, the actual residential site population may be in excess of 1,650. In addition, mill sites are likely to be present in at least 190 operations, other types of historic features such as sugar houses and charcoal kilns are likely to be present in approximately 960 operations, while stone walls may be seen in roughly 4,800 harvesting sites. Based on current data, there is no way to identify the types of prehistoric sites that might be present, except to say that they may include fairly large residential bases and smaller satellite camps dating from the time of European arrival to as early as 8,500 B.C.

Based on the results from 78 sample operations, several trends seem likely to continue. First, there will be a conscious effort to avoid most visible structural remains, although some 200 may be directly affected during the next decade. Second, and perhaps more importantly, truck roads, skidder trails, and landings are likely to disturb potentially significant archaeological deposits at a large number of historic and prehistoric sites. It is anticipated that during the next decade there will be roughly 850 occurrences of disturbance within 20-100 feet of residential foundations, and approximately 300 disturbances within 20 feet of a foundation. Unfortunately, the actual data loss cannot be predicted at this time. With respect to potential prehistoric sites, the sample data suggest that if present practices continue, there will be approximately 800 occasions where there will be at least some harvesting induced disruption and that serious disturbance may occur roughly 160 times over the next decade.

It might also assist future evaluations of the status of archaeological resources if foresters or loggers were asked to notify the Vermont Division for Historic Preservation of any historic sites that they encounter within a harvesting operation. Such notification would include a brief description and map. It should be recognized however, that if such notification might reasonably result in delaying or limiting timber harvesting, full participation should not be expected without some type of incentive program.

The potential loss of significant archaeological information seems serious enough to warrant a change in present management practices. To a large extent this may be accomplished through a concerted effort to educate loggers, foresters, and landowners about the importance of and methods for preserving archaeological sites. It is clear that site preservation is not often considered when negotiating timber sales or when planning landings or laying out trails. For example, for the 59 operations where contracts were written, only six (10%) contained any provisions related to archaeological sites. Four of these were for operations on federal land where such provisions are mandated, one was for a state lands operation, and one was for harvesting on private forest land. This is in stark contrast to considerations of water or aesthetic qualities which were addressed in roughly 75% of the contracts. Although the data are difficult to quantify, there appears to be an equal amount of disruption near archaeological sites regardless of whether a forester assisted with the operation or not.

Recommendations

Relative to archaeological resources, two courses of action are recommended.

(1) We recommend that the Vermont Department of Forests, Parks and Recreation include in timber harvesting publications a brief discussion of the need to preserve Vermont's rich cultural heritage, and a summary of recommended management practices that might mitigate archaeological site losses (refer to Appendix D for some suggested guidelines).

(2) We recommend that the Department of Forests, Parks and Recreation convene a small study group in 1990 to further explore the issue of predictable site loss and to identify educational and perhaps legislative mechanisms for counteracting apparent trends. The Department of Forests, Parks and Recreation, the Division for Historic Preservation, foresters, representatives from forest industry, loggers, and members of Vermont's archaeological community should be involved. If, after a thorough review, the study committee felt that special guidelines were needed, various options could be pursued. These might include the development of a strong educational program involving landowners, loggers, and foresters throughout Vermont, and although far more regulatory in nature, more formal guidelines may be considered. Precedent for such an approach already exists in the Vermont Historic Preservation Act of 1975 (Sect. 743), which clearly instructs State agencies "to institute procedures to assure that their plans, programs, codes and regulations contribute to the preservation and enhancement of sites ... of archaeological or cultural significance."

6 Threatened and Endangered Species

Introduction

Timber harvesting operations have the potential for enhancing the habitat of endangered or threatened plants or animals, but it is unlikely that endangered species would benefit from timber harvesting unless the operation is specifically designed for that purpose. Special provisions in the logging contract should clearly identify operations intended to provide or improve habitat for threatened or endangered species. Without such provisions in the contract, or specific field observations indicating specialized objectives, it is assumed that any impacts resulting from harvesting operations on a site with endangered species will be detrimental.

The critical question is whether or not the operation was conducted on a site where such species are known to exist or are thought to exist. The fact that there was harvesting at such a site does not necessarily mean that there was an impact on the species in question. For example, if a rare plant exists on rocky outcroppings in the middle of a harvesting operation, logging may not necessarily have impacted the plant because steepness of the site prevented logging in the immediate vicinity of the outcroppings. Alternatively, the operation may have inadvertently obliterated the plant from the site, and field observations would not indicate that the plant was ever there. It should be noted that normal silvicultural activities are afforded some degree of exemption from provisions of Vermont's Endangered Species Act.

The Vermont Natural Heritage Program of the Agency of Natural Resources is responsible for evaluating selected harvesting operations in light of their potential negative impact on threatened and endangered species. In most cases for animals, but in far fewer cases for plants, communities of, or critical habitat for, threatened or endangered species have been reported, confirmed, and mapped. Such maps make it possible for the Program to recommend special operating provisions or to even recommend against harvesting altogether. All threatened or endangered species have not been located or mapped. Therefore, in addition to maps, the Program uses a classification system based on ecological land types to determine if a proposed harvesting operation should have a special field survey conducted before logging. The purpose of the survey is to ascertain whether or not there is potential for negative impact by the operation, and to make recommendations when appropriate.

The Program assisted with the present study by reviewing mapped locations and tally sheets of the sampled harvesting locations. They compared logging sites with maps delineating known locations of rare species and significant natural communities, and National Wetland Inventory maps. For any potential impacted species, the Program's standard assessment provided information about statewide importance and legal status (as per the Vermont Endangered Species Law, 10 V.S.A. Chap 123), federal legal status, and worldwide rarity and endangerment rating.

The Program's assessment does not establish impact. If the operation was conducted in an area where threatened or endangered species are known to occur, then a special survey would be necessary to determine the extent of any negative impact. Such specialized surveys were beyond the scope of this study. Alternatively, if the site was judged as being potentially significant based on ecological land typing, no meaningful post-harvest evaluation was possible because there was no pre-harvest confirmation that the species actually occurred on the site.

Results

None of the 78 harvesting operations were located on mapped areas of endangered or threatened plant species; only 2 (3%) were located near regions where rare plants are known to exist. An additional 2 operations (3%) had physiographic characteristics that might indicate rich herbaceous habitat and thus the possible presence of unusual herbaceous plants.

Likewise, no harvesting operations were located near known locations of resident endangered wildlife. However, one operation was conducted close to a lake where common loons nest. Although the harvesting operation apparently did not interfere with nesting, this was a known nesting site that could have been verified with the Natural Heritage data base. It is noteworthy that this operation took place on public land.

One endangered bird, the spruce grouse, and three species classified as "species of special concern" (a category that has no legal implication but indicates the possibility of future proposals for listing as endangered or threatened), three-toed woodpecker, black-backed woodpecker, and gray jay, are found in extensive stands of spruce-fir forests in the northeast portion of Vermont. As noted later (see Wildlife Habitat section), there is concern that this forest type is being harvested heavily and that future impacts on threatened or endangered wildlife are possible.

The occurrence of two harvesting operations in the vicinity of rare or endangered plant habitat and the proximity of one operation close to a nesting loon demonstrates the possibility of harvests on such sites. Because seed sources of such plant species are, by definition, rare, once such a site is harvested and an endangered or threatened species is adversely impacted, these impacts are likely to be long-lived and may be permanent. Therefore, we view harvesting impacts on endangered or threatened species as being cumulative in nature and, unlike many harvesting influences, not likely to be offset by any "recovery" period. Thus, disturbance of endangered or threatened species, even if it occurs infrequently, may be a serious problem over the long term.

Recommendations

We recommend that copies of maps produced by the Vermont Natural Heritage Program be distributed to all county foresters, State lands foresters, and as many consulting foresters as possible. The only effective first step to minimize impacts of harvesting on endangered and threatened plant species is to know where these species are located and to distribute that information as widely as possible.

7 TIMBER QUALITY AND PRODUCTIVITY

Introduction

Timber harvesting operations alter the physical site and biota of a forest. For example, felling of selected trees can change the species composition and age/size distribution of the arborescent component; and both felling and removal processes can cause damage to, and thus change in, advance regeneration and the shrub/herbaceous component. Alterations in the physical site, particularly soil factors, may result from various harvesting-related activities requiring the use of relatively heavy machinery, including road construction, skidding, bunching, and hauling. For these reasons, any assessment of impacts to forests resulting from harvesting should consider harvesting-related alterations in not only the stand's overstory and understory, but also its4soil properties.

Many changes in the biota or physical site may be viewed as either beneficial or detrimental, depending upon perspective and the owner's current and future goals. For example, a patch clearcut resulting in complete removal of a poorly formed red maple stand might incorporate substantial soil disturbance in an attempt to promote yellow birch regeneration. While the resulting biotic and physical changes to the site might be substantially greater than those in a mature sugar maple stand that had been selectively cut, they are not necessarily detrimental; in fact, they may be viewed as beneficial and necessary to meet the silvical requirements of the favored species. However, if these soil disturbances resulted in substantial erosion, particularly involving transport into a stream, the impact would be viewed negatively. It is apparent that characterizing disturbance or alteration as beneficial or detrimental can hinge on managerial or cultural aspirations.

The soil related parameters chosen for this portion of the study were soil disturbance, i.e., exposure of mineral soil, and soil erosion. While other soil factors including compaction and nutrient relationships are potentially significant, most Vermont forest activities occur on harvest rotations that are, theoretically, long enough to preclude these as major harvesting-related soil impacts. In contrast, soil erosion is a significant impact and is relatively easily quantified. Soil disturbance is important because it almost certainly increases the potential for erosion (i.e., predisposition to erosion), and because it can influence the rate of colonization and species composition of subsequent regeneration on the site.

In addition to the two soil parameters, four vegetative parameters were judged as being within the study's scope and of high probable importance relative to timber quality and productivity. These parameters were (1) the extent of mechanical damage to the residual stand; (2) changes relative to pre-harvest conditions in the species composition of the residual stand; (3) the adequacy of residual stocking; and (4) the abundance and species composition of regeneration after harvesting.

Changes in species composition of the residual stand, relative to the stand's pre-harvest condition, are important because they are indicative of the stand's quality at present and into the immediate future. Changes can, of course, be either positive (removal of less desirable species or diseased or damaged stems) or negative (removal of desirable species or the highest quality material within the stand). Interpretations of changes must recognize owner objectives and the possibility that the removed material may have been defective or undesirable.

The importance of mechanical damage to the residual stand needs little explanation; injury of this type reduces merchantability and vigor, and increases risks of insect and disease infestation.

Quantity and quality of regeneration are important in several ways. Adequate regeneration of commercially-valuable species is a requisite for acceptable future stand structure. Changes in species composition of regeneration relative to the original stand are significant because harvesting practices can appreciably alter a stand's future composition. These alterations can be positive (introduction of more valuable species or species better adapted to the site) or negative (favoring or introducing less desirable species).

Analysis and Results

Soil Disturbance

Each harvesting operation was evaluated for the presence of bare mineral soil within the forest stand by visually examining five systematically located points (12-foot radius) around each of six random plots. Seventy-one of the 78 harvesting operations (91%) had some bare mineral soil exposed. Forty-seven of the 78 operations (60%) had mineral soil exposed on at least 3 of the 6 plots. There were no apparent trends in the distribution of these 47 operations by region, public versus private ownership, silvicultural objective, UVA enrollment, or involvement of a forester.

Soil disturbance and exposure of mineral soil during harvesting operations most likely result from mechanical disruption by harvesting equipment. Thus, exposure of mineral soil on at least some portion of a harvest operation may be a frequent occurrence. Mineral soil exposure may be viewed as beneficial and necessary in regenerating certain species. However, it can also be detrimental in that it may promote surface erosion. Rill or gully erosion (as described in the next section) was detected on about 30% of the 47 operations that had mineral soil exposed on at least 3 of their 6 plots. In contrast, only about 10% of the remaining 31 operations contained rill or gully erosion. Since the frequency of erosion on operations with bare mineral soil exposed on at least 3 of 6 plots was about three times greater than that on operations with less soil disturbance, unnecessary soil disturbance should be avoided. However, it seems unlikely that the level of soil disturbance typically observed in this study will result in large negative site impacts, particularly in light of the fact that some soil disturbance is culturally beneficial for many economically valuable timber species.

Soil Erosion Within Harvested Stands

Erosion within each timber harvesting operation was evaluated by visually examining five systematically placed points (12-foot radius) around each of six randomly located plots. The severity of soil erosion was rated as (1) none; (2) rill (to 6 inches deep); (3) initial gully (6-12 inches deep); (4) marked gully (12-24 inches deep); or (5) advanced (over 24 inches deep).

Seventeen of the 78 harvest operations (22%) exhibited some erosion (Table 7-1). However, erosion was only detected infrequently within these 17 operations; of the 510 sample points examined on the 17 operations, only 37 (7%) exhibited any erosion: 34 points with rill, 1 point with initial gully, and 2 points with marked gully erosion. In the great majority of cases (88%), erosion was detected on, at most, 2 of the possible 30 sample points per operation.

Table 7-1. Soil erosion on sample points that contained some erosion within 17 timber harvesting operations in Vermont in 1988.

Number of Sample Points per Operation Exhibiting Erosion (30 possible)	Percentage
1	53
2	35
3	0
4	6
5-12	6
13-30	0

Each of the 2,340 points that were evaluated for erosion was classed according to the silvicultural practice that prevailed in the immediate vicinity of the point. These site-specific silvicultural assessments were used to gain insight into the occurance of erosion (of any type) that is associated with the various silvicultural practices. Of the 2,340 points, 2,325 were attributable to four common silvicultural practices, clearcutting, shelterwoods, group selections, and selection-thinnings. To determine the relative frequency of erosion within each type of silvicultural practice, we divided the number of sample points exhibiting erosion by the total number of sample points in that type of silvicultural practice. Frequency of erosion varied from a high of 4% for clearcut points to a low of 1% for selection-thinning points (Table 7-2). Thus, although

Table 7-2. Soil erosion on sample points within the four most common silvicultural harvesting operations in Vermont in 1988.

Silvicultural practice	Total points	Frequency of erosion	Percentage of erosion
Clearcut	360	15	4
Shelterwood	645	11	2
Group selection	155	3	2
Selection-thinning	1,165	8	1
Total	2,325	37	

clearcut points tended to have a higher frequency of erosion, erosion was not common for any silvicultural practice.

Analysis of these results provided some interesting insights. Operations that exhibited some level of erosion (at least 1 of 30 sample points exhibited erosion) represented:

- 32% of the operations in the northern region, as compared with 12% of southern region operations;
- 23% of the operations on government-owned land, as compared with 17% of operations on privately-owned land;
- 62% of the operations on which landowners identified their objectives as non-silvicultural, as compared with only 14% of lands with silvicultural objectives;
- 10% of the operations under the Use Value Appraisal program, 26% of the operations on property eligible for the Program but not currently enrolled; and 38% of the operations on lands ineligible for the Program; and
- 15% of those operations on which a forester was involved, as compared with 50% of those operations without a forester.

In summary, soil erosion within stands (i.e., not on truck roads or landings) occured relatively infrequently on a harvest-operation basis (22%). Furthermore, on those operations exhibiting some evidence of erosion, erosion appeared not to be widely distributed (occurred on only 7% of the possible points). Although erosion appeared to occur more frequently on clearcuts (4% versus 2% or less for other silvicultural operations), its occurrence was still relatively rare. Even though erosion occurred infrequently, there seemed to be some trends associated with its occurrence. It was much more frequent on harvests performed for reasons other than silviculture; it appeared to be more frequent on lands either not enrolled in or ineligible for UVA; and it was more frequent on harvests performed without forester involvement.

Residual Stand Damage

Damage to residual stands was estimated around six randomly located points per harvest operation. At each point, a variable-radius plot was established with a ten-factor prism. Each tally tree was evaluated for several types of damage on the portions of its stem visible from plot center: (1) bark rubbed off; (2) roots exposed or damaged; (3) top broken; and (4) tree bent and destroyed. Prism tally trees with any of these conditions, singly or in combination, were considered damaged. Using these scores, the percentage of damaged basal area was computed for each plot (basal area of damaged trees expressed as a percentage of total residual basal area); these percentages were then averaged by operation to produce a mean percent basal area damaged for each of the 78 operations.

Stand damage ranged from 0 to 46% of residual basal area; the average was about 9%. Sixty-seven of the 78 operations (86%) had some damage, but only 13 operations (17%) had 15% or more of their residual basal area damaged (Table 7-3).

Stand damage did not appear to vary with UVA enrollment, forester involvement, public versus private ownership, or whether or not silviculture was an ownership goal. However, 24% of harvests in the northern region had residual stand damage greater than 15%, as compared with only 10% of harvests in the southern region.

It is not surprising that some level of residual stand damage was recorded; heavy equipment operating within a forest will almost certainly result in mechanical damage. In a study that examined residual stand damage following a single tree selection harvest in a hardwood forest in West Virginia, Lamson et al. (1985) reported that about 23% of the basal area of residual stands was damaged. Our findings of about 9% average basal area damage seem to compare favorably with their reported levels. However, our methodology examined only those portions of stems visible from a central point, i.e., generally about half of a stem's circumference, and therefore probably underestimated actual damage levels.

Table 7-3. Distribution of residual stand damage for 78 timber harvesting operations in Vermont in 1988.

Percentage of basal area damaged	Percentage of operations
0-4	30
5-9	34
10-14	20
15-19	6
20-24	5
25-29	3
30-34	1
35-39	0
40-44	0
45-49	1

Damage to smaller stems is probably less serious than injury to larger more mature trees. In the present study, about 14% of the basal area damage occurred on stems less than five inches dbh, compared with about 24% found by Lamson et al. (1985). Differences between these percentages probably reflect differences in the silvicultural treatments being assessed. The present study included a variety of harvesting methods, whereas the West Virginia study evaluated only single tree selections under uneven-aged management, conditions under which a high proportion of smaller stems might be expected within a stand. Regardless of these differences, levels of residual stand damage observed in this study do not appear excessive.

Residual Stand Composition

Within each harvesting operation, residual stand overstories were characterized using cover types of the Society of American Foresters (Eyre 1980) on each of six randomly located plots. Pre-harvest cover types were estimated by species-identification of stumps and by incorporating estimates of removed overwood into residual stand conditions. Influence of harvesting on residual stand composition was evaluated by comparing these pre- and post-harvest cover types.

Twenty-eight of the 78 operations (36%) exhibited a cover type change on at least one plot. Of the 168 plots on those operations with at least one cover type change (28 operations x 6 plots per operation), 85 (51%) showed cover type shifts.

Of the 85 plots that shifted cover type, 34 (40%) retained an overstory, but its species composition changed (Table 7-4); this results from the selective favoring of one species or species group either within or between crown canopy positions. The remaining 51 plots (60%) had their overstory removed as a result of clearcutting for either silvicultural purposes, agricultural conversions, or land development. Hardwood seedlings or coppice were the most frequent understory vegetation resulting from the harvesting operations (Table 7-5).

There were no apparent trends in cover type shifts with region, public versus private land ownership, or participation versus non-participation in

Table 7-4. Distribution of changes within the 34 plots that shifted cover type as a result of 78 timber harvesting operations in Vermont in 1988.

Overstory cover type shifts From	To	Percentage of plots (n = 34)
Hardwoods	Other hardwoods	6
	Softwoods	3
Softwoods	Other softwoods	12
	Hardwoods	30
	Mixed-wood	6
Mixed-wood	Softwoods	6
	Hardwoods	37

Table 7-5. Distribution of understory types within the 51 plots that had their overstories removed as a result of timber harvesting operations in Vermont in 1988.

Resulting understory vegetation	Percentage of plots (n = 51)
Hardwood seedlings or coppice	66
None--building lot	12
Grass-pasture (agricultural conversion)	12
Ferns-herbs-rubus	8
Mixed-wood seedlings	2

UVA. However, 77% of those operations without silvicultural goals showed cover type shifts, as compared with 28% for those with an identified silvicultural goal. And, 63% of operations without forester participation had cover type shifts, as compared with only 29% of operations with forester involvement.

In summary, a minority of operations (36%) exhibited cover type changes. Of those which did, they did so on about half (51%) of their sample plots. Of those plots that showed cover type changes, 40% represented changes in species composition within a remaining overstory. The remaining 60% changed by virtue of complete overstory removal; of these, 68% contained tree reproduction, 24% were effectively removed from further forestry activities (agricultural conversions and development) and cannot be evaluated from a vegetative standpoint, and the remaining 8% are in the fern-herb-*Rubus* category.

Residual Stocking

Residual stocking levels were characterized on the basis of one variable-radius plot established with a ten-factor prism on each of six randomly selected locations per timber harvesting operation. Type of silvicultural treatment was also recorded at each location. Because some harvest operations incorporated several silvicultural treatments, all residual stocking evaluations were made on a plot rather than on a harvest operation basis.

Selection harvests/thinnings

Evaluations of residual stocking levels for selection harvests and thinnings were made on the basis of published guidelines for white pine (Lancaster and Leak 1978), northern hardwood (Leak et al. 1987), hemlock (Tubbs 1977), spruce-fir (Frank and Bjorkbom 1973), and mixed-wood (Leak et al. 1987). Because our sample survey did not determine even aged versus uneven aged management, our evaluations for each plot scored as a selection/thinning were made using guidelines developed for both management strategies. Generally, in terms of evaluating acceptable levels of residual stocking, these guidelines agreed; when they did not, we considered acceptable stocking for either management approach as constituting an acceptable level of residual stocking. For white pine cover types, only even-aged management guidelines were consulted.

Table 7-6. Plots with insufficient residual stocking following selection or thinning timber harvesting operations in Vermont in 1988.

Forest type	Total plots	Percentage of plots with insufficient residual stocking
White pine	51	33
Mixed-wood	51	20
Spruce-fir	7	14
Hemlock	11	9
Northern hardwood	146	9
Total	266	

In general, partial cuttings in northern hardwoods appeared to be adhering to published recommendations (Table 7-6). However, with the exception of hemlock stands, partial harvests in softwood and mixed-wood stands showed a tendency towards leaving an understocked residual stand. This may have resulted from a lack of understanding that stands with softwood cover types typically carry much higher residual basal areas than do hardwood stands at the same relative stocking level.

Shelterwood harvests

Adequacy of residual stocking within shelterwood harvests is difficult to access. It depends on site quality, pre-harvest total stand density, pre-harvest stand density of the species or species mix desired in regeneration, and shade tolerance of the species or species mix desired. For the purposes of this study, we have defined "insufficient" residual basal area after shelterwood harvesting as less than 50 square feet per acre.

Table 7-7. Plots with insufficient residual stocking (less than 50 feet square basal area per acre) following shelterwood timber harvesting operations in Vermont in 1988.

Forest type	Total plots	Percentage of plots with insufficient residual stocking
White pine	29	34
Mixed-wood	18	56
Spruce-fir	15	40
Hemlock	2	0
Northern hardwoods	66	21
Total	130	

On the basis of our definition of insufficient residual stocking, there appeared to be a strong tendency to leave insufficient basal area following shelterwood harvests (Table 7-7). With the exception of hemlock stands, this tendency seemed more pronounced for softwood and mixed cover types than for northern hardwoods.

Clearcuts

It is not uncommon to find residual material present after clearcutting. In this study, of a total of 72 clearcut points, 17 (24%) had measurable residual basal area. Typically this consists of small, damaged stems, and possibly some unmerchantable stems of considerable size; this is generally undesirable because the material interferes with subsequent stand development and may provide a seed source for non-valuable species. However, a few standing snags may also be desireable in that they provide nesting or perching sites for wildlife. In order for clearcutting to produce high-quality even-aged stands of desirable species, residual trees that are not intended for wildlife should be kept to a minimum.

Reproduction

Condition of reproduction within each harvesting operation was characterized by evaluating, on six randomly located plots, the expected dominant vegetation three to five years after cutting. Most of the 78 operations had sufficient tree reproduction, but 10 (13%) were considered to be insufficient because at least three of their six plots were without tree reproduction (either no vegetation, or fern, herbaceous, *Rubus*, or shrub).

On the 10 operations with inadequate reproduction, 45 of their 60 plots were without tree reproduction. Of these 45 plots, 12 (27%) were in harvesting operations that had removed lands from forest production and therefore reproduction would not be desirable; 18 (40%) occurred beneath silvicultural treatments (shelterwoods and group selections) designed to promote future regeneration; and 15 (33%) occurred beneath selection/thinning harvests. (Since the sampling scheme did not differentiate selection harvests from thinnings, we are unable to determine exactly how many were in each.)

For true thinnings in even-aged management practices, presence of regeneration may not be important because such practices eventually involve silvicultural treatments designed to encourage establishment of reproduction. But, selection harvests under uneven-aged management generally rely on release of advance regeneration of tolerant species. For these harvests, lack of adequate tree species reproduction could be a serious problem.

Recommendations

(1) Less than 30% of operations with mineral soil exposed on at least three of six plots exhibited erosion. However, disturbed soil appeared more prone to subsequent erosion than did undisturbed forest floors. Therefore, timber harvesting operations should be conducted with equipment, and at times of the year, which minimize soil disturbance *unless such disturbance is intentional and necessary to meet silvicultural goals*.

(2) Harvesting did not appear to cause meaningful increases in erosion within stands. Erosion that did occur is probably transitory. However, we do not mean to minimize the seriousness with which one must view erosion. Data from this study indicate that harvests performed on lands where forest practices are perceived as important (silviculture identified as an objective, enrollment in UVA, and involvement of a forester) are likely to experience little erosion. Therefore, we advocate that the Department of Forests, Parks and Recreation and the Extension Service jointly develop educational programs whose goals would be to convey to landowners the types of managerial decisions, and their likely results, that must be made relative to timber harvesting. Such programs might include insights into different silvicultural treatments, basic silvical strategies for common forest cover types, and relative site impacts of different harvesting equipment.

(3) Most harvesting operations did not exhibit excessive damage to their residual stands. There were no apparent trends to stand damage, other than an inexplicable tendency for operations in the northern region to exhibit a greater frequency of residual stand damage greater than 15%. Since the level of damage is probably most strongly related to operator care during harvesting, the only realistic way to reduce stand damage is to impress upon landowners that levels of residual damage largely depend on their selection of a careful operator. Printed guidelines that would assist forest landowners in selecting an operator should be prepared jointly by the Department of Forests, Parks and Recreation and the Extension Service, and made generally available through the Extension Service, and county and consulting foresters.

(4) Most harvesting operations did not result in changes in cover type, and only 40% of plots that did exhibit cover type changes did so without a complete removal of their overstory. There is a longstanding concern that partial harvests may remove the most valuable component of a stand, leaving a less valuable residual stand, and that this effect is cumulative. Without pre-harvest stand characterizations, this is a difficult factor to estimate, and the present study's design would probably pick up only the most blatant cases. Frequent shifts in cover type indicative of complete removal of the most valuable stand components were not observed in this study. Landowner education is probably the most efficacious method of preventing this type of harvesting.

Sixty percent of plots with cover type changes did so by virtue of complete removal of their overstory. The majority of these plots contained adequate tree seedling or coppice reproduction. However, 24% of cleared plots were cleared for either agricultural conversion or land development. Determination of whether removal of these lands from the forested land-base is beneficial or detrimental is beyond the scope of this study. However, it is noteworthy that about one fourth of cleared plots in this study are essentially lost to future forest practices.

(5) In general, residual stocking levels after selection/thinning or shelterwood harvests in hardwood and hemlock forest types appear adequate. However, for the other softwood and mixed-wood types, there appeared to be a tendency toward leaving insufficient residual basal area. This is probably due to a lack of understanding that stands of softwood cover types typically carry higher residual basal areas than do hardwood stands at the same relative stocking level. Again, the most effective way of countering this trend is likely to be through education of all concerned parties including harvesting operators, foresters, and landowners.

(6) About 24% of clearcut plots contained measurable residual basal area. With the exception of stems left for wildlife purposes, residual material present after clearcutting is undesirable. We recommend that landowners make provisions in their timber sales contracts that specify that this material be felled and either removed or left on site.

(7) In general, reproduction following harvesting was either present in adequate quantities, or the silvicultural treatment applied seemed designed to encourage subsequent establishment of reproduction. Possible exceptions are areas beneath selection harvests lacking advanced regeneration. This study did not discriminate between thinnings under even-aged management and selection harvest under uneven-aged management. Thus, we cannot adequately determine the frequency of selection harvests without advanced regeneration. True uneven-aged management depends on regular replenishment of younger age classes, generally in the form of advance regeneration, a portion of which is eventually released through selective harvesting to occupy resulting openings in the overstory. Practicing individual tree selection harvests in the absence of advance regeneration *may* result in deficiencies in some age classes within the stand. In the absence of advance regeneration, we recommend small group selections to create canopy openings more favorable to establishment of regeneration.

8 WATER QUALITY

Introduction

Improperly managed timber harvesting operations have long been cited to result in adverse water quality impacts. The primary causes of water quality deterioration are usually sediment from transportation networks, equipment crossings of streams, and timber removal immediately adjacent to streams. The primary water quality impacts are increased turbidity and sedimentation, and increases in stream temperatures. These stream changes can adversely affect aquatic life, especially cold water fisheries. Some increases in nutrients in streams draining cutover areas can also be expected.

To protect water quality, a number of management practices have been developed. It is generally believed that when these practices are followed, water quality impacts will be minimized. Vermont has recently implemented Acceptable Management Practices (AMPs) to protect the State's waters. Compliance with these practices and an evaluation of water quality impacts from timber harvesting operations in Vermont were the objectives of the water quality portion of this study.

Each of the 78 timber harvesting operations was evaluated for compliance with existing statutes, rules, and regulations as well as for the impacts on water quality as detailed in Appendix A. Measures for the mitigation of those impacts are summarized in the Recommendations section. Nearly one-third of the operations did not involve an adjacent waterbody, which, for the purposes of this study, was meant to include streams, lakes, and wetlands (Table 8-1). Over one-half of the operations involved streams and most of these streams were intermittent.

Table 8-1. Waterbody types associated with 78 Vermont timber harvesting operations in Vermont in 1988.

Waterbody type	Frequency	Percentage
No adjacent waterbody	24	31
Intermittent stream	34	44
Permanent stream	16	20
Lake	1	1
Wetland	3	4

Operations were evaluated for compliance with 18 of the 24 Acceptable Management Practices (Vermont Department of Forests, Parks and Recreation 1987). Six of the AMP's applied to active operations and could not be evaluated after completion of the operation.

Analysis and Results[1]

Water Quality Impacts

Post-audit impacts from the Vermont timber harvesting operations are summarized in Table 8-2. Only impacts with obvious lingering effects were assessed, including the change in stream temperature and turbidity from above to below the operation, sedimentation, woody debris, and petroleum spills. Nutrient effects could not be monitored in this study. In order to more accurately assess water quality impacts, each operation would need continuous monitoring, both before and after harvesting. For this study, sampling was conducted in one day and does not represent the full range of water quality effects anticipated.

Table 8-2. Water quality impacts from 78 Vermont timber harvesting operations in Vermont in 1988.

Impact	Percentage		
	No waterbody evaluated	Impact	No impact
Stream temperature increase (>2° F)	51	4	45
Stream turbidity increase (above 10 NTU)	77	4	19
Waterbody sedimentation	31	32	37
Stream crossing sedimentation	37	36	27
Waterbody debris	31	45	24
Stream crossing debris	37	35	28
Petroleum spills	3	4	93

The quality of waters draining timber harvesting operations is directly related to runoff-producing precipitation. Higher sedimentation and turbidity is associated with higher stream flows. Over one-half of the operations were evaluated within 24 hours of a precipitation event (Table 8-3).

1 Due to the breadth of the existing body of water quality literature, frequent citations are made throughout this portion of the report. These citations are presented to help serve as a background comparison for this study. The subsequent recommendations are based on the analysis of our sample data and not on findings from the literature.

Table 8-3. Precipitation in the 24 hour period preceding site evaluation of 78 timber harvesting operations in Vermont.

Precipitation Amount	Frequency	Percentage
No rain	36	46
Light rain	25	32
Rain	16	21
Heavy rain	1	1

Stream Temperature

A change of plus or minus 2° F, observed at 38% of the operations, was not considered an impact but was considered measurement error in this study. Decreases in temperatures were observed in streams draining 6% of operations. Stream temperatures below the operations were greater than above the operations by more than 2° F for 4% of operations (Table 8-2). Of these three operations where temperature increases occurred, the increases at two exceeded the Vermont water quality criteria for temperature in warm water fish habitat (Vermont Water Resources Board 1987). Temperatures increases at two of these streams were due to loss of protective strip vegetation. An increase of 5.4° F occurred as water from a groundwater spring flowed through the third operation.

Clearcutting or other removals of buffer strips has repeatedly been shown to result in increases in summer stream temperatures ranging from 4° F to 28° F with most increases averaging 12° F depending on the location and site conditions (Swift and Messer 1971, Lee and Samuel 1976, Rishel et al. 1982, Brown 1983). Vegetated buffer strips have been demonstrated to prevent water temperature changes (Burton and Likens 1973, Swift and Baker 1973, Rishel et al. 1982, Lynch and Corbett 1989).

Stream Turbidity

Similarly to temperature impacts, turbidity increased beyond Vermont water quality standards of 25 NTU for warm water fish habitat below three operations or 4% of the total number of operations (Table 8-2). Turbidity increases were related to grazing for one operation and to a stream crossing for a liquidation operation; the largest increase was observed at a newly developed house site.

Skid roads near streams and other logging roads have been reported elsewhere to increase stream turbidity from 25 JTU to 56,000 JTU depending on planning considerations (Eschner and Larmoyeux 1963, Hornbeck and Reinhart 1964, Patric and Reinhart 1971, Brown 1983). Proper road design and maintenance of riparian vegetation has been shown to reduce turbidity changes (Aubertin and Patric 1974, Patric and Aubertin 1977).

Sedimentation

Stream sediment was observed in nearly one-third of the operations (Table 8-2). For those operations where some evidence of sedimentation was observed, 16% had sediment at over one-third of the points checked in the stream (Table 8-4). Heavy sedimentation, which is where alluvial fans, coated rocks, and bank

Table 8-4. Sedimentation increases above background conditions in streams and wetlands affected by timber harvesting operations in Vermont in 1988.

Percentage of stream impacted	Percentage of operations by stream type		
	Total	Intermittent	Permanent
<33	17	9	8
33-66	8	5	3
>66	8	5	3

cutting occurred, was observed on only five (6%) of all operations (Table 8-5). Grazing was also occurring on one of those five operations in addition to streamside harvesting. An additional 25 operations had evidence of a moderate amount of sedimentation; that is, a thinly coated streambed. Of these, one operation was influenced by grazing and another by a town road.

Table 8-5. Type of sedimentation observed in streams and wetlands affected by timber harvesting operations in Vermont in 1988.

Type of sedimentation	Frequency	Percentage
Stable bed and clean rocks	51	64
Thinly coated streambed	25	32
Coated rocks and alluvial fans	5	6
No adjacent waterbody	24	31

Sedimentation effects were primarily observed in intermittent streams (63%), although some permanent streams (30%), three wetlands, and one lake were affected as well. Since many first-order streams occur on forest lands, it is not surprising that more intermittent streams than permanent streams would be impacted.

In a 1982 New Hampshire survey of sedimentation in timber harvesting operations, 48% of operations with streams and ponds showed evidence of sedimentation (DeHart 1982), which is similar to our findings.

Sedimentation also was observed at stream crossings in one-third of the operations and at over one-half of the operations with stream crossings (Table 8-2). The number of stream crossings observed per operation ranged from one to seven and averaged two. Two-thirds of the crossings were over intermittent streams. About three-quarters of the crossings were for skid trail use (Table 8-6), and almost half the crossings were skid trail fords. Of the operations showing sediment at stream crossings, 27% had more than one-third of their stream crossings associated with some evidence of erosion (Table 8-7). Heavy sedimentation was observed at 11 operations (14%), and moderate sedimentation was observed at 22 operations (Table 8-8). Sedimentation observed at all of the 11 operations with heavy sedimentation appeared to be a direct result of the operation.

Table 8-6. Types of stream crossings used in timber harvesting operations in Vermont (n = 117) in 1988.

Crossing type	Percentage Truck road	Skid trail	Total
Metal culvert	18	2	20
Wooden culvert	<1	4	4
Ford	4	45	50
Bridge	3	2	4
Log ford	0	10	10
Other	<1	0	<1
Removed	0	10	10
Total	25	73	

Table 8-7. Sedimentation increases above background conditions at stream crossings in timber harvesting operations in Vermont in 1988.

Percentage of impacted stream crossings	Percentage of operations by stream type Total	Intermittent	Permanent
<33	9	3	6
33-66	14	3	11
>66	13	5	8

Table 8-8. Level of sedimentation observed at stream crossings in timber harvesting operations in Vermont in 1988.

Type of sedimentation	Frequency	Percentage
Natural	40	51
Thinly coated streambed	22	28
Coated rocks and alluvial fans	11	14
No stream	29	37

Unexpectedly, stream crossings appear to have a fairly high potential for causing stream sedimentation in Vermont timber harvesting operations. The impacts of stream crossings themselves have generally not been reported in the literature. Studies have not factored out stream crossing impacts from the more general skid trail and truck road impacts.

Debris

Woody debris beyond background levels was observed both in waterbodies within operations (24% of operations) and at stream crossings (28% of operations) (Table 8-2). At least one debris unit was found per chain of stream length examined in eight operations (10%), and one debris unit was found every two chains for 26% of the operations (Table 8-9). Debris was found in both intermittent as well as permanent streams in proportion to their occurrence in harvested sites. The presence of debris did not appear to be related to operations showing stream sediment. Only two of the eight operations with more than one debris unit per chain also had evidence of stream sediment.

Table 8-9. Woody debris in streams and wetlands affected by timber harvesting operations in Vermont in 1988.

Debris units per chain	Percentage of operations by waterbody type			
	Total	Intermittent stream	Permanent stream	Wetland
<0.5	25	19	6	
0.5-1.0	8	6	1	1
>1.0	10	6	4	

Debris at stream crossings was observed for one-third of the operations (Table 8-2). About one-quarter of the operations had debris at over two-thirds of their stream crossings (Table 8-10). More debris was observed in permanent

Table 8-10. Woody debris increases above background levels at stream crossings in timber harvesting operations in Vermont.

Percentage of impacted stream crossings	Percentage of Operations by Stream type		
	Total	Intermittent	Permanent
<33	8	1	6
33-66	15	5	10
>66	12	4	8

streams than intermittent streams, even though they represented fewer streams. Sufficient debris to alter streamflow occurred at 15 (19%) of the operations (Table 8-11).

Table 8-11. Levels of debris observed at stream crossings in timber harvesting operation in Vermont in 1988.

Type of sedimentation	Frequency	Percentage
Natural	41	53
Moderate	17	22
Alter streamflow	15	19
No adjacent stream	29	37

Although allowing debris in streams and at stream crossings appears to be a fairly common practice, the significance of the debris for water quality is debated. According to Brown (1983), debris in streams changes stream stability, causing an accumulation of sediment upstream of the debris and causing scouring downstream. Debris also can alter flow directions and result in channel shifts. Failure of debris dams can result in stream bank and stream bed scouring and clogging of downstream bridges and culverts (Brown 1983). Woody debris can also prevent fish passage (Bilby 1984).

On the other hand, debris can trap organic matter and provide cover for some fish (Bilby 1984). Increased detritus in streams can also contribute habitat and food for macroinvertebrates (Martin et al. 1985). Bilby (1984) indicated that the primary problems are associated with unstable debris which includes tree tops and branches. He recommended that slash be removed to reduce accumulations at barriers. However, long, buried, or anchored pieces should not be removed from streams as they contribute to pool formation.

Petroleum Spills

Evidence of spills of petroleum and related products was observed at the log landings for three (4%) operations (Table 8-2). In one case, oils could reach a nearby intermittent stream.

The Vermont Water Quality Standards (Vermont Water Resources Board 1987) indicate that there should not be discharges of oil and grease in concentrations that would have an adverse effect on beneficial uses such as fish. Oils and petroleum can harm aquatic life in several ways, including clog fish gills, destroy algae, coat benthic organisms, and cause toxicity, both acute and chronic in fish. About 40 mg/l of gasoline has been cited as the toxic threshold for rainbow trout (McKee and Wolf 1963).

Existing Statutes Compliance

The timber harvesting operations were evaluated for compliance with three State regulations related to water quality. Act 250 (10 V.S.A. 6001 (Sec. 3), 6081) requires a permit for logging above 2,500 feet in elevation. None of the 78 operations included harvested areas above 2,500 feet. A permit is also required (10 V.S.A. 1021, 1025) to alter or modify a stream with a drainage area greater than ten square miles. Although several of the operations had qualifying stream crossings, these stream crossings were pre-existing and no additional alteration occurred as a result of the timber harvesting operations. The Water Pollution Control Act (10 V.S.A. 1259, 1274) requires that silvicultural operations discharging waste must obtain a permit unless the "Acceptable Management Practices For Maintaining Water Quality on Logging Jobs in Vermont" (AMP's) are in place. There was no evidence to suggest that any of the 78 sampled operations were exempt from the AMP's. Therefore, compliance was evaluated in detail for all of the operations.

Studies have repeatedly shown that managed, forested watersheds generally produce higher quality water in terms of temperature, turbidity, sediment and nutrient concentrations than urban, agricultural, and mixed land uses (Dillon and Kirchner 1975, Omernik 1976). Timber harvesting can be conducted so that there are only minimal, short-term impacts to water quality if best management practices are implemented (Eschner and Larmoyeux 1963, Lynch et al. 1985, Martin et al. 1985, Beasley and Granillo 1988). Even if the appropriate (best or acceptable) management practices are not in place, most water quality impacts from harvesting are of short duration and water quality rapidly returns to preharvest conditions (Hornbeck et al. 1970, Hornbeck 1973, Bormann et al. 1974, Patric and Aubertin 1977).

Before summarizing the findings, two important precautionary notes are required. First, a majority of the transportation networks associated with timber harvesting operations exhibited post-sale uses. These uses included non-motorized mountain bikes, all-terrain vehicles, equestrians, pick-up trucks, and hikers. No attempt was made to quantify the impact of these post- sale activities on AMP compliance and erosion occurence. However, post-sale uses were common and they resulted in reduced AMP compliance and increased erosion. Secondly, AMP compliance failure may not always result in reduced water quality. Other AMP's can be compensatory in that failure to comply with one may be offset by implementation of another. For example, maintaining an adequate protective strip can reduce stream sedimentation from an inadequately drained skid trail.

Each timber harvesting operation was evaluated for compliance with applicable AMP's for truck roads, skid trails, log landings, and streams and other waterbodies. Operations were considered to be in compliance with a particular AMP if all observations met or exceeded recommendations. AMP's for roads, trails, log landings, and streams are summarized separately.

Truck Road Compliance

Each operation was evaluated for compliance with three AMP's relating to truck roads (Table 8-12). Less than one-third of the operations were located within two chains of a town or state road or were accessed by a temporary truck road. Most permanent truck roads were properly constructed with regard to grade in that only 9% of operations had permanent truck roads with segments in excess of 10% grade for over 300 feet.

Table 8-12. Compliance of truck roads with the Acceptable Management Practices (AMP'S) on timber harvesting operations in Vermont in 1988.

AMP No. and Practice		Percentage	
		Yes	No
1.	Steep pitches (10%) on permanent truck roads will not exceed 300 feet.	61	9
2.	(Permanent truck) road surfaces shall be adequately drained with culverts and broad-based dips.	6	64
12.	Waterbars on temporary roads shall be properly installed at intervals shown in table 1 of the AMP's.	0	4

Only 6% of the operations had permanent or temporary truck roads that were adequately drained according to AMP specifications, and almost two-thirds of the operations did not meet the drainage criteria. Draining truck roads adequately can be an expensive proposition if metal culverts are used exclusively. Less expensive solutions for draining truck roads, such as broad-based dips, were not commonly used on Vermont timber harvesting operations.

The compliance of timber harvesting operations with AMP's pertaining to truck roads were summarized by region, ownership type, prime objective for the operation, Use Value Appraisal (UVA) enrollment, forester involvement,

Table 8-13. Compliance of timber harvesting operations in Vermont in 1988 with truck road Acceptable Management Practices (AMP's) by region, ownership type, prime objective, Use Value Appraisal (UVA), forester involvement, and harvesting method.

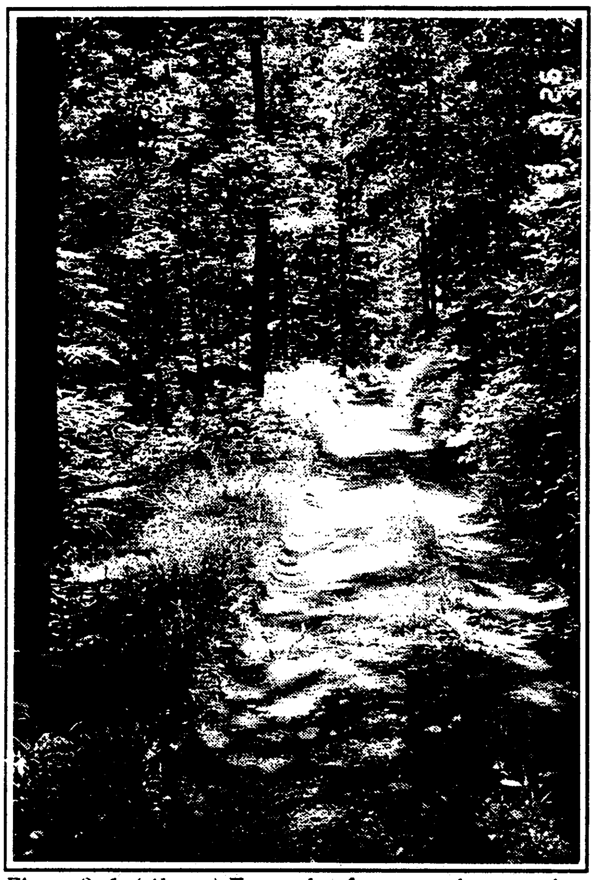
	Percentage in compliance	
	Steepness (AMP No. 1) (n = 55)	Drainage (AMP No. 2) (n = 55)
Region		
South	87	10
North	87	8
Ownership		
Public	90	10
Private	87	9
Objective		
Silviculture	86	8
Non-Silviculture	100	17
UVA		
Enrolled	86	9
Not Enrolled	87	9
Not Eligible	90	10
Forester		
Forester	91	11
No Forester	67	0
Method		
Wholetree	100	20
No Wholetree	86	8

and harvesting method (Table 8-13). The AMP pertaining to the waterbarring of temporary truck roads was not summarized because none of the operations were in compliance. There does not appear to be much difference in truck road AMP compliance between regions, ownership type, harvesting objective, UVA enrollment, forester involvement, or harvesting method. Since there were an insufficient number of expected observations in a category, the frequencies could not be tested for statistical differences.

Truck roads were also evaluated for the surface erosion types that were occurring. In the early stages of the data collection, it was relatively easy to distinguish between no apparent erosion and sheet erosion with minute rills present. However, with the rapid revegetation of the roads, this difference became less clear. Therefore, these categories were combined into one surface erosion type, which was referred to as "none to sheet, with minute rills" (Figure 8-1). The remaining surface erosion types are illustrated in Figures 2 through 4. On the average, 81% of the truck roads had none to sheet surface erosion as the most advanced surface erosion type (Table 8-14). There was no advanced gully erosion observed on the truck roads of any harvesting operation. Therefore, the amount of surface erosion that occurred on truck roads accessing Vermont timber harvesting operations was relatively low.

Table 8-14. Types of erosion occurring on truck roads in timber harvesting operations in Vermont in 1988 (n = 58). Percentages are means of individual percentages.

Erosion type	Percentage
None to sheet	81
Rill	16
Initial gully	2
Marked gully	1
Advanced gully	0



Skid Trail Compliance

Each operation was evaluated for compliance with the three AMP's pertaining to skid trails (Table 8-15). About 5% of operations had post harvest activities that precluded AMP compliance evaluation of the main skid trails. Skid trails on 9% of operations had segments in excess of 20% grade for over 300 feet. Location of skid trails "at a gradual angle across the slope", as suggested in the AMP's, was not a commonly observed practice. Previously existing skid trails were commonly used and, on several of the operations, fuelwood access roads that had been cost-shared through the Agricultural Stabilization and Conservation Service (ASCS)

Figure 8-1. (Above) Example of none to sheet erosion on a Vermont logging truck road.

Figure 8-2. (Right) Example of rill erosion on a Vermont logging truck road.

Figure 8–3. (Above) Example of initial gully erosion on a Vermont logging truck road.

Figure 8–4. (Below) Example of marked gully erosion on a Vermont logging truck road.

provided excellent access. Therefore, once a good skid trail network was established, it received repeated use in subsequent harvesting operations.

Ruts on skid trail segments that showed any type of post harvest gully erosion were considered to be evidence of having the potential for gullying. About 20% of operations had skid trails that required additional smoothing to prevent erosion (Table 8-15).

32% of operations with landings that failed to comply, some may have been used exclusively under winter conditions resulting in minimal site impacts.

The log landings on 24% of operations were at least partially located in the protective strip of a stream or waterbody (Table 8-18). This frequency was higher than may have been expected; however, landings were generally located in the lower elevations of the sale area where there was a higher percentage of area in protective strips. The landings tended to be close to permanent, all-season roads, which were built on flat areas near streams to reduce construction costs. Although many landings were located in the protective strip, 73% of them had a surface erosion type of none to sheet erosion. Of the landings located in the protective strip, 18% had been seeded and mulched.

To determine if necessary grading and draining had been conducted, the landings were evaluated for existing and potential surface erosion as well as proximity to a waterbody. Over 75% of operations were adequately drained and graded (Table 8-18). Post-sale uses reduced the effectiveness of grading and draining activities on landings. Over half of the operations exhibiting rill or initial gully erosion on log landings had evidence of post-harvest vehicular use. The closeout activity in these cases may have been sufficient to prevent sedimentation if subsequent vehicular use had not occurred. However, log landings often remained accessible for post-harvest uses including firewood cutting and recreation.

The compliance of timber harvesting operations with log landing AMP's pertaining to stability, location, and closeout were summarized by region, ownership type, prime objective, UVA enrollment, forester involvement, and harvesting method (Table 8-19). There were no significant differences between landing stability, location in the protective strip, and adequacy of closeout to prevent sedimentation between regions or UVA enrollment.

Log landings were examined for the erosion types that were occurring (Table 8-20). On the average operation, 92% of the landings had none to sheet erosion as the most advanced surface erosion type. There was almost no gully erosion occurring on the log landings.

In summary, although portions of landings were located in the protective strips, most of the operations complied with the AMP's pertaining to log landings. The amount of log landing sediment that reached streams and other waterbodies was probably very low.

Streams and Other Waterbodies Compliance

Each operation was evaluated for compliance with the nine AMP's pertaining directly to streams and other waterbodies. There was no evidence of the use of silt fencing and haybale erosion checks on evaluated skid trails. Haybale erosion checks were used on the landings of 3% of the examined operations.

Almost half of the operations had slash or logging debris in streams or other waterbodies (Table 8-21). Of the observations with slash, 68% were located in intermittent streams. These streams may not have been active during the operation or not visible if operated under winter conditions.

Table 8-19. Compliance of timber harvesting operations in Vermont in 1988 with log landing Acceptable Management Practices (AMP's) by region, ownership type, prime objective, Use Value Appraisal (UVA), forester involvement, and harvesting method.

	Percentage in compliance		
	Grade and stability (AMP No. 15) (n = 76)	Protective strip (AMP No. 16) (n = 76)	Water diversions (AMP No. 23) (n = 76)
Region			
South	66 NS	73 NS	78 NS
North	68	77	80
Ownership			
Public	75	83	100
Private	66	73	75
Objective			
Silviculture	68	75	80
Non-silviculture	64	73	73
UVA			
Enrolled	71	71	71
Not enrolled	59 NS	76 NS	79 NS
Not eligible	75	81	94
Forester			
Forester	70	75	81
No forester	54	77	69
Method			
Wholetree	57	71	71
No wholetree	68	75	80

NS No significant difference at 0.10 confidence level.

Table 8-20. Types of erosion occurring on log landings in timber harvesting operations in Vermont in 1988 (n = 76). Percentages are means of individual percentages.

Erosion Type	Percentage
None to sheet	92
Rill	7
Initial gully	1
Marked gully	0
Advanced gully	0

Nearly 70% of the operations did not involve truck road crossings of permanent streams. Of the operations that did, nearly 80% had properly installed culverts or bridges. The operations that failed to comply had used fords or other inadequate structures to cross the stream.

Skid trail stream crossings that had gravel or ledge bottoms and approaches with no rill or gully erosion were considered stable. About one-half of the

Table 8-21. Compliance of timber harvesting operations in Vermont in 1988 with the Acceptable Management Practices (AMP's) pertaining to streams and other waterbodies.

AMP No. and Practice		Percentage	
		Yes	No
7.	Silt fencing, haybale erosion checks, or water diversions shall be used to prevent sediment from entering streams and other surface waters.	0	69
8.	Streams and all bodies of water shall be kept free of slash and other logging debris.	24	45
9.	Truck road crossings of all permanent streams shall be over a bridge or a culvert.	25	6
	Streams may be forded by skid trails only where streambeds have stable beds and approaches.	26	24
10.	Logging activities shall be kept out of stream channels.	58	6
11.	Turnups or broad-based dips shall be used before a truck road or skid trail crosses a stream.	4	59
13.	Stream crossings shall be made at right angles where possible.	41	22
14.	Except for necessary construction of stream crossings, a protective strip shall be left along all streams and other bodies of water in which only light harvesting can occur.	54	15
	Log transport machinery must remain outside a 25 foot margin along the stream or water body.	50	19
21.	All non-permanent structures shall be removed from streams and the channel restored.	33	30
22.	Following the close of operations, all approaches to streams shall be stabilized, seeded, and mulched.	0	63

operations had unstable skid trail stream crossings, and these were probably a major source of the observed sediment. Actual skidding in streams was limited to 6% of operations (Table 8-21).

Discharge of road surface water prior to all stream crossings occurred on only 4% of operations. On nearly 80% of the stream crossings, there were no attempts to install turnups or broad-based dips before the crossings. In a few cases, broad-based dips were installed but they were too close ($<$ 25 feet) to the stream to be effective. All stream crossings were made at right angles on 41% of operations.

There were no apparent changes or only light thinnings in the protective strip of 54% of operations. Over 80% of operations where protective strips were not maintained according to the AMP's involved intermittent streams. Over

94% of the protective strip observations had either no cutting or light thinnings. These protective strips were probably important in capturing sediment from the transportation networks with the exception of stream crossings.

Stream crossings were evaluated for the removal of non-permanent structures. Structures were considered to be non-permanent if they were log fords, brush fords, or undersized drainage structures. On skid trails and temporary truck roads, culverts and bridges were considered temporary unless noted by the field investigator. On nearly 30% of the operations, non-permanent structures were left in place (Table 8-21).

None of the examined operations had all stream crossings and approaches seeded and mulched. Many operations had crossings that appeared to have been seeded. Two operations had some crossings that were both seeded and mulched and these crossings were generally located close to the landings.

Table 8-22. Compliance of timber harvesting operations in Vermont in 1988 with Acceptable Management Practices (AMP's) pertaining to streams and waterbodies by region, ownership type, prime objective, Use Value Appraisal (UVA), forester involvement, and harvesting method.

	Percentage in compliance			
	Logging debris (AMP No. 8) (n = 54)	Skid trail fords (AMP No. 9) (n = 39)	Logging in channel (AMP No. 10) (n = 54)	Turnups or dips (AMP No. 11) (n = 50)
Region				
South	30 NS	40 NS	100	8
North	42	63	80	4
Ownership				
Public	14	100 **	83	29
Private	38	42	91	2
Objective				
Silviculture	30 *	56	88	6
Non-silviculture	71	0	100	0
UVA				
Enrolled	35	56	95	5
Not enrolled	35 NS	31	85	0
Not eligible	7	86	90	25
Forester				
Forester	30 *	59	90	7
No forester	67	0	89	0
Method				
Wholetree	100	100	100	0
No wholetree	30	46	89	7

NS No significant difference at .10 confidence level.
\+ Significant at .10 confidence level.
* Significant at .05 confidence level.
** Significant at .01 confidence level.

Table 8-22. Compliance of timber harvesting operations in Vermont with Acceptable Management Practices (AMP's) pertaining to streams and waterbodies by region, ownership type, prime objective, Use Value Appraisal (UVA), forester involvement, and harvesting method (Continued).

	Percentage in compliance							
	Crossing angle (AMP No. 13) (n = 49)		Protective strip (AMP No. 14) (n = 54)		Buffer strip (AMP No. 14) (n = 54)		Non-permanent structures (AMP No. 21) (n = 49)	
Region								
South	67	NS	87	+	77	NS	54	NS
North	64		67		67		52	
Ownership								
Public	71		100		57		57	
Private	64		74		74		52	
Objective								
Silviculture	65		81	NS	70		52	
Non-silviculture	67		57		86		67	
UVA								
Enrolled	73		83		74		59	
Not enrolled	53	NS	60		70	NS	42	
Not eligible	75		100		73		62	
Forester								
Forester	69	NS	84		69		52	
No forester	43		44		89		57	
Method								
Wholetree	75		75		100		50	
No wholetree	64		78		70		53	

NS No significant difference at .10 confidence level.
+ Significant at .10 confidence level.
* Significant at .05 confidence level.
** Significant at .01 confidence level.

The compliance of timber harvesting operations with AMP's pertaining to stream crossings and other waterbodies were summarized by region, ownership type, prime objective, UVA enrollment, forester involvement, and harvesting method (Table 8-22). Operations that involved a silvicultural objective or a forester had a significantly lower compliance regarding slash and debris in streams, and there were no significant differences by region or UVA enrollment. Publicly owned lands had a significantly higher compliance regarding stable skid trail stream crossings, but there were no significant differences by regions. It appeared that operations on publicly owned lands involved more planning and careful location of the skid trail stream crossings. There were no significant differences in stream crossing angle compliance by region, UVA enrollment, or forester involvement. The southern region had a significantly higher rate of compliance regarding protective strip canopy condition and this may have been attributable to the predominance of light selection cuts in the southern region.

Recommendations

(1) Timber harvesting transportation networks receive repeated use over time. Design of timber harvesting transportation networks should anticipate post-harvest use; and cost-share programs that facilitate long-lasting design should be encouraged.

(2) Post-harvest use of skid trails, truck roads, and log landings was commonly encountered but post-harvest maintenance was not common. Transportation network layout and closeout activities should be conducted so that post-harvest uses are accommodated without increased erosion and sedimentation. In situations where post-harvest use is not appropriate, closeout activities should actively restrict access by installing sufficiently large drainage structures.

(3) The use of log waterbars on skid trails and broad-based dips on truck roads should be encouraged.

(4) Tables for drainage structure spacing on truck roads and skid trails appear to require more structures than needed, and the recommended spacing between waterbars and other structures should be examined in light of current research. The excessive number of structures required may discourage the use of any structures.

(5) Skid trails and truck roads should be more carefully located with respect to stream crossings. The number of stream crossings should be minimized, and crossings should be made in the most appropriate locations. It should be recognized that stream crossings will receive repeated future uses.

(6) Fords of permanent streams should not be allowed except under unusual circumstances.

(7) Crossing streams over brush fords should be discouraged because they are frequently not removed.

(8) The AMP's should clearly specify what constitutes a stream to make it clearer as to when the AMP's pertaining to streams should be applied.

(9) The impact of slash in streams should be re-evaluated.

(10) Stream crossings are the major source of the sediment from timber harvesting operations in Vermont; methods to reduce these impacts should be evaluated in detail.

(11) The protective strip is critical for maintaining stream temperatures and preventing sedimentation. Protective strip entries and cutting should be minimized and conducted under optimal conditions. Most operations have excellent protective strips, and operators should be encouraged to continue this extremely important practice.

(12) Additional research on the short and long term impacts of timber harvesting operations on water quality is essential. Most of the research that has been conducted to date has evaluated the effectiveness of best management practices similar to Vermont's AMP's. Research has also evaluated the impact of timber harvesting without the application of appropriate management practices. Harvesting operations in Vermont fall between these two extremes and these impacts have not been studied.

(13) Educational efforts aimed at reducing water quality impacts should continue, and demonstration areas on public and private lands should be established.

9 WILDLIFE HABITAT

Introduction

Timber harvesting operations have the potential for improving habitat for many wildlife species, but harvesting operations also may have adverse impacts on wildlife. In general, the number of wildlife species in forested environments is related to patterns of horizontal and vertical forest structure. Diverse structure is a product of different age classes and diversity of plant species. Wildlife species vary widely in their tolerance to changes in forest structure. Some species are quite specialized in their habitat requirements; others are more flexible. Some require mixes of different age classes; others select large expanses of similar forest stands. Some prefer edges; other avoid edge habitats.

Without expressly stated objectives for wildlife priorities in timber harvesting operations, it is reasonable and customary to evaluate operations for their impacts on "featured species." Appropriate species to feature are those that have recognized value as game animals (e.g., white-tailed deer and black bears) or those that are of special concern because of their status as rare species (e.g., spruce grouse and black-backed woodpeckers). Therefore, only special habitat requirements of featured wildlife species were considered in evaluating direct impacts of timber harvesting. Examples were softwood stands with the potential to provide protective cover for deer in winter; or stands of beech, oak, or other mast-producing species that provide important food resources for deer, black bears, turkeys, and other species. Although harvesting operations can be conducted in such areas, special conditions are often imposed.

Several harvesting practices indicate a conscious effort to promote featured wildlife species. For instance, the creation of small clearcuts to favor vegetative regeneration of aspen favors ruffed grouse. The release and pruning of apple trees is another practice that indicates a concern for wildlife. Improving vigor of apple trees benefits deer, bear, grouse, and a number of nongame species. Another practice that favors wildlife is the retention of standing or fallen trees that are dead, damaged, or diseased. These trees provide nesting, roosting, and escape cover for more than 40 common species of wildlife in Vermont. Cavity trees or snags should be present in reasonable numbers (2-5 per acre) after timber harvesting.

Three levels of data collection were used in evaluating the effects of timber harvesting operations on wildlife habitat. Interviews with a contact person for each operation indicated whether a conscious effort was made to manage for featured wildlife. Indicators of such an effort were whether or not there were specific provisions in the plan or logging contract for wildlife habitat management, whether a professional wildlife biologist or a professional forester was consulted, whether the operation took place on government land, or whether the land parcel was managed according to guidelines for the Use Value Appraisal program. To varying degrees, each of the above criteria assures that someone with training in wildlife habitat management was involved in planning or conducting the operation.

The second level of information comprised notes taken during field surveys indicating if timber harvesting operations involved any of the following special practices for wildlife: (1) maintaining softwood cover in deer wintering areas, (2) releasing or pruning apple trees, (3) encouraging aspen regeneration in small clearcuts, (4) retaining mast-producing trees, (5) retaining snag and den trees, and (6) "daylighting" logging roads (removing shade-producing trees from edges of roads) to encourage growth of non-woody plants.

Finally, data collected on six sample plots in each harvesting operation were used as the basis for general observations about probable responses of wildlife species assemblages to future stand conditions projected to result from operations. For these evaluations, wildlife were considered as early-, mid-, or late-successional species. Interpretations of these projections are necessarily tied to regional or statewide trends of forest conditions. For instance, changes in wildlife species composition as a result of clearcutting would be much more significant in a region where clearcutting was obvious over a significant portion of the landscape than in a region where clearcutting was not a common practice.

Analysis and Results

Characteristics of Timber Harvesting Operations

Professional foresters were consulted in 60 harvesting operations, but wildlife biologists took part in only 11 of 75 samples where this information was available (Table 9-1). However, 6 of these 11 operations were on government-owned land, where consultation by wildlife biologists probably was required. Thus, biologists were involved on only five operations on private parcels; four of these were on nonindustrial private forestland.

Table 9-1. Characteristics of 78 timber harvesting operations in Vermont in 1988 that indicate wildlife management considerations.

Characteristic or management practice	Frequency		
	Yes	No	Unknown
Enrolled in UVA	31	46	1
Government land	12	66	0
Wildlife biologist consulted	11	64	3
Forester consulted	60	16	2
Provisions in contract for wildlife	13	42	4

It was not surprising that wildlife biologists were not consulted more often because it is generally assumed that consulting foresters are adequately versed in techniques for managing wildlife habitat (and many actively advertise that expertise). There are few, if any, wildlife biologists in Vermont who regularly provide consultation on forest management plans prepared for private land holdings. Nevertheless, conscious efforts to improve wildlife habitat, as indicated by specific enhancement practices, were remarkably widespread. This may be the product of an active continuing education program in wildlife habitat management conducted by the Vermont Agency of Natural Resources, the UVM Extension Service, and the USDA Forest Service.

Thirteen contacts reported that special provisions for wildlife were included in harvesting contracts. Interestingly, only four contracts with such provisions involved a consulting wildlife biologist or fell on government land. In total, 26 different operations (33%) either involved a wildlife biologist, took place on government land, or had special provisions for wildlife in the harvesting contract. Of 31 operations that took place on lands that were enrolled in the Use Value Appraisal program, 22 were on parcels that were not government-owned, did not have involvement by a wildlife biologist, and had no special provisions in the contract for wildlife. Thus, 48 (62%) of the operations sampled satisfied one of the criteria suggesting that wildlife habitat had been considered before or during the harvesting operation.

Wildlife Practices

The most common harvesting practice that directly affected wildlife was the high incidence of retained snag and den trees after harvest (Table 9-2). Based on assessments by the field investigator, 88% of the harvesting operations left snag and cavity trees on the site. Furthermore, 12% of trees tallied on 468 sample plots were classified either as soft snags (7%) or hard snags (5%). Soft snags are trees that are mostly or entirely dead and partially decayed; they serve as important sources of food and cover for a variety of wildlife species. Hard snags are trees that are still mostly alive, but have broken tops, large broken limbs, sapwood or heartwood decay, or obvious cavities. Hard snags provide nest and roosting sites for woodpeckers, flying squrrels, and numerous other species (Figure 9-1).

Table 9-2. Wildlife practices evident on 78 timber harvesting operations in Vermont in 1988.

Practice	Frequency	Percentage
Retaining snag and den trees	69	88
Regenerating aspen	38	49
Retaining mast trees	37	47
Daylighting roads	28	36
Seeding log landings[a]	18	15
Managing deer wintering areas	19	20

[a] n = 120.

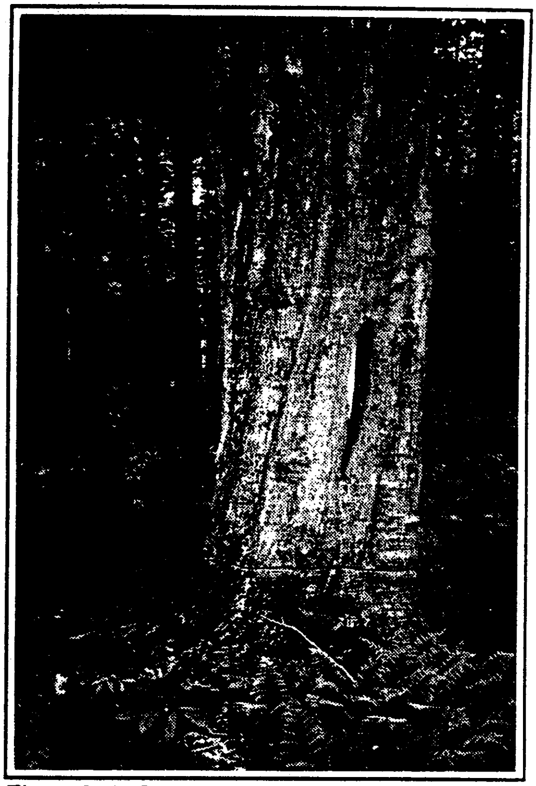


Figure 9–1. Large cavity tree created by girdling.

Field assessments indicated that regeneration of aspen was occurring or expected in almost half the operations. Likewise, mast trees were retained in about half the areas harvested (Table 9-2). Efforts to daylight roads were evident in 28 operations, and 18 of 120 log landings were seeded. Landings averaged 0.3 acres, with 22 being 0.5 acres or larger in size. Unless log landings are converted to other uses (e.g., one was developed into a campground), they usually enhance wildlife habitat for early successional species for at least a few years following the harvest.

Nineteen of the 78 operations contained residual cover indicating that deer had used or might use the remaining stands for wintering habitat (Table 9-2). Logging practices on all 19 sites indicated that the potential for deer habitat had been recognized before cutting and that adequate softwood cover remained. In several instances, adjacent stands had been cut in a manner that would provide abundant browse from regenerating hardwoods. In one operation, however, a softwood stand had been removed prompting the field investigator to note, "any deer wintering that may have occurred prior to the cut has been eliminated." (This was not one of the 19 stands mentioned above.) Additional notes about that site further indicated that the operation was a poor one in most respects.

Data were tested statistically to determine if any of the six special wildlife habitat practices occurred in higher-than-expected proportions in the following comparisons: (1) northern versus southern region, (2) government versus non-government land, (3) operations for silvicultural purposes versus those cut for other purposes, (4) lands in Use Value Appraisal program versus those not in the program, (5) operations where foresters were consulted versus those without foresters, and (6) those where whole-tree harvesting took place versus those with other types of harvest. Virtually all comparisons showed no significant differences (Chi-squared tests, $P > 0.10$).

Three cross-tabulation tests were significant, however. More mast trees were left after logging where a forester was consulted ($P = 0.003$) than where no forester was involved, and more mast trees were left in operations where silviculture was the primary objective ($P = 0.054$). The other significant comparison documented that 74% of softwood stands managed as deer wintering areas fell on land in the UVA program; the expected proportion was only 16% ($P = 0.002$).

Although 77% of operations involved a professional forester, wildlife enhancement practices were not significantly more common on those parcels than on lands where no forester was involved, except for the retention of mast trees after harvesting. Likewise, specific wildlife practices were not found to be more common than expected on government land or land in the UVA program. However, differences between some of these categories may have been non-significant because of small sample sizes in some groups. Therefore, we can state, with confidence, that these practices were not found to be more prevalent on one type of operation or ownership than on another type. But we cannot conclude that there were no differences. Larger samples would be necessary to adequately test such relationships.

Silvicultural Practices

Types of harvesting practices varied considerably. Selection cuts, on average, accounted for 49% of harvested areas; seed tree or shelterwood cuts averaged 27%; clearcuts accounted for 16% of harvested areas; and group selection averaged seven percent (Table 9-3). Clearcuts accounted for more than 80% of harvest on only 11 parcels and most of these were small operations, averaging 22 acres (range = 3-55). Only one large parcel (218 acres) was predominantly a clearcut. The average area harvested for all 78 operations was 93 acres, and only 16 harvested areas exceeded 100 acres.

Table 9-3. Silviculture methods used in 78 timber harvesting operations in Vermont in 1988.

Method	Percentage of each operation		
	Mean	>10	>50
Selection-thinning	49	72	49
Seed tree	27	63	0
Clearcut	16	23	15
Strip cut	0	0	0
Group selection	7	17	0

Changes in Habitat Structure

Data gathered on six sample plots per operation (total = 468 plots) indicated that 79% of samples would be dominated by trees in the near future (3-5 years) (Table 9-4). As expected, a majority of plots (64%) will feature hardwood species because hardwood stands accounted for most of the acreage in the study areas (see below). It is expected that no commercial trees will dominate 109 plots (23%), reflecting sites harvested for purposes other than silviculture. Most plots were expected to have dense understory vegetation (Table 9-4).

Table 9-4. Life form, species, and density of vegetation expected to occur on 468 survey plots on 78 timber harvesting operations in Vermont in 1988.

Expected vegetation	Frequency	Percentage
Life form		
None	1	0
Ferns and herbs	65	14
Rubus	12	3
Shrubs	3	1
Coppice	19	4
Trees	368	79
Species		
No commercial species	109	23
Hemlock	4	1
White pine	4	1
Spruce/fir	10	4
Other softwoods	1	0
Aspen-w.birch-r.maple	78	17
S.maple-beech-y.birch	217	46
Other commercial hardwoods	3	1
Mixed hardwood-softwood	42	9
Understory density		
<3 ft tall, 0-33% crown closure	19	4
<3 ft tall, 34-66% crown closure	43	9
<3 ft tall, >66% crown closure	45	10
>3 ft tall, 0-33% crown closure	110	24
>3 ft tall, 33-66% crown closure	166	36
>3 ft tall, >66% crown closure	85	18

Using data from the six sample plots on each harvesting operations, harvested sites were classified in one of five categories reflecting the residual basal area after logging. Categories ranged from complete clearcuts to minor thinning operations leaving more than 120 square feet of basal area (BA). Operations were then "weighted" by the size of the harvested area to provide the following results: (1) only 5% of 7,267 acres harvested were clearcut; (2) 30% of the harvested area was left with less than 80 BA; (3) 50% of the area harvested could be described as having about one-third of the area with residual stands with less than 80 BA; (4) 15% of acres harvested were selectively cut or thinned so that 80-120 BA remained; and (5) residual stands on only 46 acres (< 1%) were left with more than 120 BA.

Forest types in harvested stands were dominated by hardwood tree species: 70% of the acres logged were hardwood types, 9% were softwoods, and 20% were mixes of hardwoods and softwoods. Changes in cover type as a result of the harvesting operation were not common (see section on Timber Quality and Productivity) and accounted for only 2% of the area studied, using weighted data as described above.

As expected, the most obvious effect of timber harvesting operations was to improve habitat for those species that prefer edges and early successional habitat types. Nearly 50% of the area harvested was cut heavily enough to encourage dense regeneration of early successional plants (Figure 9-2). Such areas attract deer, moose, bears, grouse, hares, and a number of nongame species. Perhaps more notable, however, was that more than 50% of the area harvested was cut rather lightly, leaving a stand structure that was altered only mildly (Figure 9-3). After cutting—often a thinning operation—such sites still offer a variety of habitat conditions, but often lack a desirable density of snags and cavity trees. Wildlife species preferring late-successional forest types obviously did not benefit from harvesting operations because few stands were cut so lightly that they might have retained the multi-layered, diverse structure of an old-aged forest.

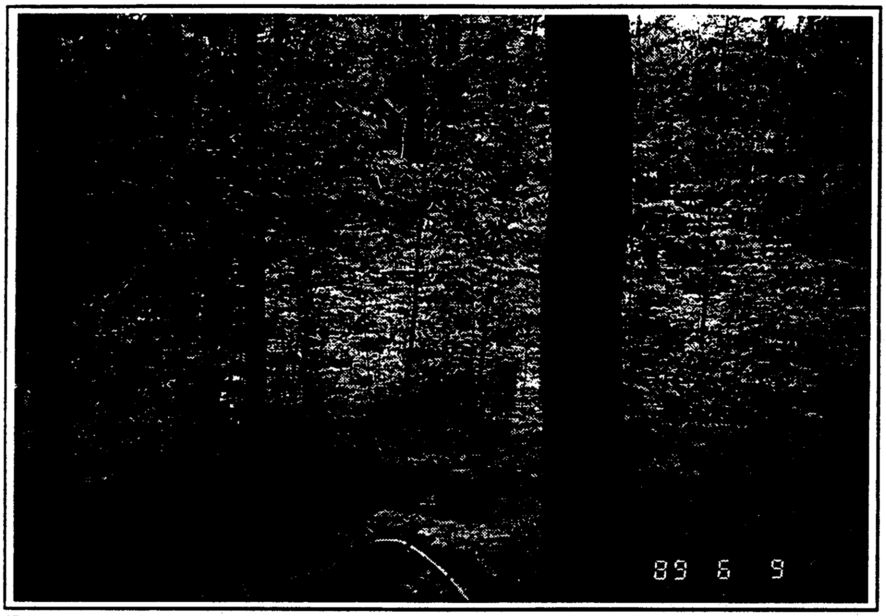


Figure 9–2. Herbaceous vegetation in response to opening in forest canopy created by selection cutting.

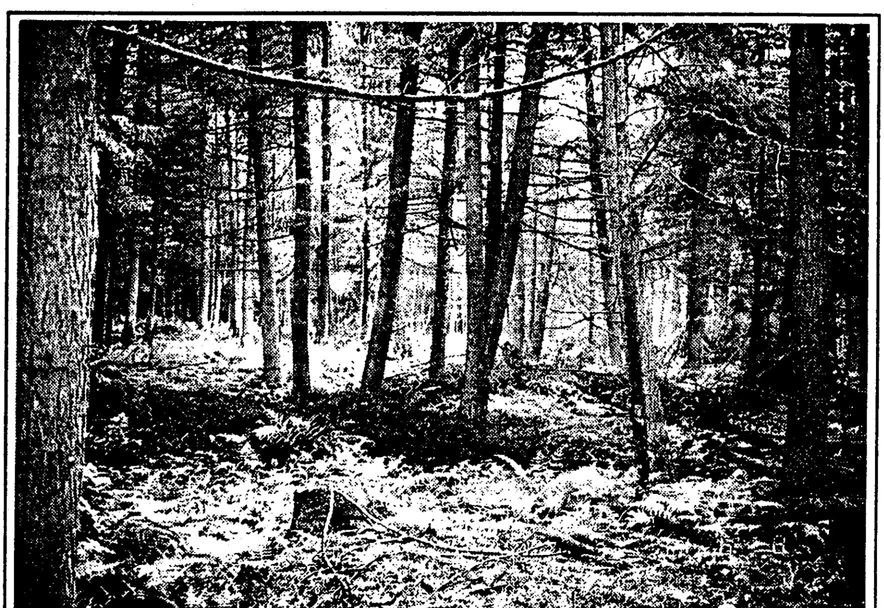


Figure 9–3. Hemlock stand showing results of light harvest, maintaining the forest overstory and winter cover for wildlife.

Impacts on Wildlife

No direct, detrimental, short-term impacts on wildlife were identified in the 78 timber harvesting operations studied. On the contrary, an encouragingly high proportion of operations exhibited conscious management practices that indicated a desire to improve wildlife habitat. Most obvious among these practices were the retention of apple trees, mast-producing species, and cavity trees.

Softwood cover, a habitat type of special concern for a number of species, comprised a small percentage of areas logged and was generally harvested lightly. Clearcuts of softwood stands were not common in our sample, and those that did occur were small and usually were harvested because of land conversion rather than forest management. One softwood stand that might have offered cover for wintering deer was clearcut, but 19 other such stands were carefully managed to maintain dense canopy coverage.

To assess long-term impacts of timber harvesting operations on wildlife in Vermont, the effects of harvesting must be examined as part of the total landscape. Our sample of 78 operations represented approximately 10% of timber harvesting done in Vermont in 1988, and this total represents about 1.6% of the available timberland in the state. Therefore, long-term effects might be projected in the following ways:

Most disruptive scenario. If habitat changes took place on 1.6% of the forested landscape in 1988, then 16% of the state's habitat would be altered in a 10-year period, and 48% would change in a 30-year period. A landscape managed in this manner would result in an abundance of early- and mid-successional types and possibly a dearth of old-aged forests. Also, there is the potential for widespread changes in forest cover types in a relatively short time period.

Least disruptive scenario. Because more than 50% of the acres harvested in our sample were left with less than 80 BA of standing timber, then no more than 0.8% of the landscape was altered significantly enough to create noticeable changes in species composition of wildlife. Thus, only 8% would change in 10 years, and 24% in a 30-year period. Because much subsequent timber harvesting will be done on the same parcels (short-rotations, thinnings, shelterwood cuts, etc.), this level of forest harvesting leaves a majority of the forested landscape unharvested and available to those species that prefer unfragmented, old-aged stands.

In the past, wildlife habitat improvement routinely has been considered to be a product of forest management. In recent years, however, forest harvesting in the U.S. often has been criticized for having detrimental effects on wildlife. Much of this criticism has been leveled at widepread forest type conversions in the Southeast and the Lake States. Large-scale clearcutting has also been implicated because mid- and late-successional wildlife species have been selected against. More recently, wildlife biologists have documented the deleterious effects of a highly fragmented forest landscape on species diversity. Throughout the country, a number of threatened and endangered species document reasons for concerns about such trends in the landscape as a result of timber harvesting operations.

In Vermont, the landscape is predominated by a forest that is growing much more rapidly than it is being cut. The extent of harvesting operations documented by this study is not sufficient to trigger concerns about deleterious changes in wildlife habitat across the landscape. In fact, on a statewide basis, habitat diversity is probably being positively impacted by forest harvesting. Quite conceivably, more harvesting would further improve wildlife diversity. This conclusion assumes, however, that forested land in the state is not being lost to other uses and thus remains available to wildlife.

One concern about wildlife habitat does surface from our analysis – a fear about the possible loss of softwood forest types. Although softwood stands accounted for only 9% of the acres harvested in our sample and 98% of acres logged were projected not to show forest type changes, the majority of changes in forest type were from softwoods to hardwoods or cleared land. Thus, about 10% of the acres in softwood types were being converted. Unless softwood forests are present in the state in larger proportions than represented in our sample of logging operations, this represents cause for concern. Softwood stands are especially valuable as winter habitat for numerous species of wildlife. Protection of softwood cover has been high priority for the Vermont Fish and Wildlife Department, and recently has been recorded as a concern by one of the wildlife subcommittees of the Vermont Endangered Species Committee.

Recommendations

The most pressing need for additional study is to assess the spatial distribution of timber harvest sites in the state. A weakness of our study was the inability to assess the impact of harvesting on a site in relation to the surrounding landscape. This is probably the most important long-term need for planning the maintenance and enhancement of wildlife diversity on a statewide basis.

(1) Although an encouraging number of timber harvesting operations displayed evidence of wildlife habitat management, there are still opportunities for improvement. Wildlife management information should continue to be integrated into continuing education programs for foresters and loggers.

(2) Another mechanism that could stimulate improved management practices for wildlife would be a requirement for wildlife habitat assessment as part of management plans required by the Use Value Appraisal program. This recommendation is based on the finding that there were no significant differences between wildlife practices on lands in the UVA program and other parcels of non-public land. One would expect lands in the UVA program to demonstrate more evidence of wildlife habitat management than parcels for which management plans are not required.

10 CONCLUSIONS

From the varying individual orientations of the study team members, there were specific timber harvesting operations that contained substantial negative impacts. However, from a statewide perspective these did not have many characteristics in common and were not of sufficient numbers to be considered representative of timber harvesting in the state. Relative to the resources that we examined, the data do not suggest that timber harvesting is creating a major statewide problem. **Therefore, it is the unanimous recommendation of the study team that new legislative initiatives designed to regulate timber harvesting in Vermont are not justified at this time.** If there were to be any new legislative initiatives, they would have to be justified on other grounds.

Clearly, there are opportunities and a need for improved harvesting practices. However, given the lack of a common problem characteristic, it would seem that the responsibility for insuring any improvements rests jointly with loggers, public officials, professional foresters, forest landowners, and the general public. **We recommend that public and professional educational programs in timber harvesting and land stewardship be enthusiastically continued and expanded.** As pointed out elsewhere in the report, we also see opportunities for improvement through current statutory means. **We therefore recommend that existing statutes be more fully implemented.**

The above overall recommendations, as well as the other recommendations given at the end of each of the resource chapters, are made by the study team to the Commissioner of the Vermont Department of Forests, Parks and Recreation. Approval or endorsement of these recommendations by any public or private agency or organization has not been sought, and therefore should not and cannot be assumed.

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APPENDIX A:

DATA COLLECTION PROCEDURES

Data collection has four sections: general data, interview data, site inspection data and map data. Most of the data is self-explanatory to the experienced field forester. Items requiring additional clarification are described further under the appropriate section.

I. General Data - Consists of data gathered by the Department of Forests, Parks and Recreation and the UVM Study Team. The section provides organizational structure and limited summary information (Appendix B, page 3). It consists of twenty-six items.

1. Operation Number - The first two digits represent the county and the final two digits represent the assigned operation number.
7. Prime Objective for Timber Harvesting Operation (THO). "Silviculture" refers to vegetative manipulation for such purposes as timber production, recreation, aesthetics, hazard tree reduction, sugarbush management and wildlife habitat improvement. "Other" includes liquidation.
12-17. Silvicultural Method % - The percent of the THO area treated by silvicultural method, estimated by residual crown closure. Must total 100%.
18. Size Class Diversity - An overall characterization of the diversity and interspersion by stand size classes and stand acreage. THOs with uniform size classes over 30 acres received code 1. THOs with uniform size classes of 5 acres or less received code 3.
19. Contextual Land Use - Summary description of the land uses in the general vicinity of the THO.

II. Interview Data - Consists of 42 items (Appendix B, page 4). Contact person on general data section was interviewed unless noted on summary. Interviews were conducted by phone or in person. Maps of the operation were requested during the interview and permission for an on-site inspection was requested. If permission was denied, another operation was randomly selected.

2. Wildlife Biologist - Defined as a wildlife biologist with either the USDA Forest Service or with the Vermont Department of Fish and Wildlife.
3. Professional Forester - Defined as a person eligible for SAF membership at any level.
13. Felling equipment - Conventional felling equipment included chainsaws and hand operated saws. Mechanized felling equipment included hydraulic shears.
22-26. Seasons of THO - Those seasons in which the THO was actually in operation.
34. Total contiguous acres in ownership - All acreage in the ownership even if the ownership extended beyond town and/or county boundaries. For State Lands, this included all acreage in management unit (block).

III. Site Inspection Data - Consists of nine separate resource evaluation procedures and a summary sheet (Appendix B, pages 5-18). Three of the procedures (i.e., vegetation data, truck road and skid trail data, and landing data) were conducted on each site. The remaining six procedures were conducted when applicable.

Before initiating the resource evaluations, the timber harvesting operation was located on a USGS 7.5 minute, 7.5 x 15 minute, or 15 minute topographic map depending on availability. The operation number was placed on the map adjacent to the location of the THO.

Data collection sequence varied from site to site based on encountered resources. The evaluation procedures are reviewed in the order in which they are found in Appendix B.

A. Vegetation Data - Six point samples were conducted for each THO. The plot centers were located to provide systematic coverage of the THO. Plot centers were located on the ground by pace and compass (Appendix B, pages 6-10)

3. Preharvest size class - Seedling/sapling was 0 to 5 inches DBH; Softwood poletimber was >5 to 9 inches DBH; Hardwood poletimber was >5 to 11 inches DBH; Softwood sawtimber was >9 inches DBH; Hardwood sawtimber was >11 inches DBH. Estimate was based on stumps and residual stand.

5. Site Quality - Estimated using site indicator herbaceous plants, soils and THO sawlog heights of dominant and codominant trees. Sawlog height was the predominant factor.

	Site I	Site II	Site III	Site IV
		(Number of Logs)		
Beech-Y.Birch-S.Maple	3+	2-2 1/2	1-1 1/2	< 1
W. PIne-P. Birch	3 1/2+	2 1/2-3	2	< 2

7. Soil Drainage - Poorly drained soils had saturation periods of more than six months per year, concave topography commercially operable under frozen conditions -- and with sedges, sensitive fern, interrupted fern, cinnamon fern, cattails, and jewelweed as indicator species. Moderately well-drained soils had convex topography, depth to pan or bedrock of 1 1/2 to 3 feet and annual saturation of 3-6 months. Well-drained soils had sandy, gravelly texture, terrace or moraine topographic configuration and annual saturation periods of 0 to 3 months.

9. Surface Characteristics - Ledgy, rock outcrops had more than 25% of surface area in ledge or rock outcrops. Moderately stony had 15 to 50% of the surface area in stones or rocks. Wet had concave topography, was located at the toes of slopes, had seeps and/or wet site indicator plants such as sedges, cinnamon fern, sensitive fern, interrupted fern, jewelweed, and cattail.

A BAF-10 variable plot sample was conducted at each of the six plot centers (Appendix B, pages 6-10).

<u>(SPEC)</u> - the following species codes were used:

1 Cedar, N.W.
2 Fir, Balsam
3 Hemlock
4 Pine, Red
5 Pine, White
6 Spruce, Norway
7 Spruce, spp.
8 Softwood
9 Blank
10 Ash, White
11 Aspen, spp.
12 Basswood
13 Beech
14 Birch, Paper
15 Birch, Yellow
16 Butternut
17 Maple, Red
18 Maple, Sugar
19 Oak, Red
20 Hardwood
21 Non-commercial
22 Wildlife
23 Dogwood
24 Ironwood
25 Birch, Grey
26 Elm, Slippery
27 Elm, American
28 Hickory, spp.
29 Cherry, Black
30 Oak, Swamp White
31 Willow, spp
32 Serviceberry
33 Ash, Mountain
34 Black Locust
35 Cherry, Pin
36 Oak, Chinkapin
37 Box Elder
38 Ash, Green
39 Ash, Black
40 Cottonwood
41 Aspen, Big Tooth
42 Aspen, Trembling
43 Alder, Speckled
44 Hop Hornbeam
45 Maple, Silver
46 Maple, Striped
47 Oak, Black
48 Oak, White
49 Oak, Chestnut
50 Birch, Black
51 Apple
52-74 Blanks
75 Pine, Scotch
76 Pine, Jack
77 Pine, Pitch
78 Cedar, Eastern red
79 Tamarack
80 Spruce, White

<u>DBH</u> - The diameter breast height was estimated. About 10% of the diameters checked with a diameter tape.

<u>Soil Impacts</u> - Five 12-foot radius plots were located.

<u>Soil Plot Location</u>

Point Center

. 33' . 33' . 33' . 33' .

A B C D E

(Bearing from previous point) (Bearing to next point)

B. <u>Truck Road and Skid Trail Data</u>. (Appendix B, page 11)

<u>Functioning Drainage Structures</u> (FDS) - Any natural or man made drainage that effectively drained road surface water on skid trails and temporary truck roads. On permanent truck roads, function drainage structures included broad based dips and pole or metal culverts.

<u>Recommended Drainage Structures</u> (RDS) - These were determined by conversion of Table 1 in the "Acceptable Management Practices for Maintaining Water Quality on Logging Jobs in Vermont" (AMPs) from feet to chains as shown below.

Recommended number of waterbars for skid trails and temporary truck roads after logging.

Road Grade	Per 1.5 ch.	Per 2 ch.	Per 3 ch.	Per 8 ch.
0-1%	.2	.3	.5	1.3
1-2%	.4	.5	.8	2.1
2-5%	.7	1.0	1.5	3.9
5-10%	1.2	1.6	2.5	6.6
10-15%	1.7	2.2	3.3	8.8
15-20%	2.2	2.9	4.4	11.7
20-25%	2.5	3.3	5.0	13.2
25-30%	2.8	3.8	5.7	15.1
30-40%	3.3	4.4	6.6	17.6

Recommended number of culverts for permanent truck roads.

Road Grade	Per 2 chains	Per 8 chains
0-1%	.3	1.2
1-2%	.4	1.8
2-5%	.7	2.6
5-10%	.9	3.8
10-15%	1.0	4.1
15-20%	1.1	4.4

C. <u>Stream and Surface Water Data</u> (Appendix B, page 12)

<u>Turbidity</u> - Turbidity (Nephelometric Turbidity Units) from 1 grab sample each above and below the THO impacted area. Turbidity determined on a Hack Ratio Turbidimeter within 48 hours of collection.

<u>Buffer Strip Entries</u> - Area (other than skid trail or truck road stream crossings) where logging equipment, including bulldozers or rubber tired skidders operated within 25 feet of the stream channel.

<u>Debris</u> (DEB) - Tops and logging debris from one tree considered as 1 debris unit.

<u>Skidding in Streams</u> (SKID) - Operating skidding equipment in the stream channel other than skid trail crossings.

D. Stream Crossing Data. A systematic method for locating stream crossing sites was not used. Stream crossing data compiled as stream crossing sites were encountered during the site evaluation (Appendix B, page 11).

Stream Type (STREAM) - Permanent streams determined from the USGS topographic maps. Other streams considered to be intermittent. Exceptions were noted.

Turnups or BBD before crossing - Identified if found within 132 feet of the stream crossing, at the bottom of slopes approaching a stream crossing and a minimum of 25 feet from the stream crossing.

E. Landing Data. All landings associated with THO were evaluated separately (Appendix B, page 12).

Land in Protective Strip (STRIP) - Determined from Table 4 in the AMPs Graded and Diversions Installed as needed - determined by landing area slope, evidence of surface erosion and potential for sedimentation.

F. Historic Sites Data. Compiled if encountered during the site evaluation (Appendix B, page 13). Site components (ex. H-1) were located on the USGS map and substantial site components were sketched on the USGS map.

G. Potential Prehistoric Sites Data. Compiled if encountered during the site evaluation as well as from the USGS maps (Appendix B, page 13).

Each potential site (ex. A-2) located on the USGS map.

Pitmound - Area characterized by hummocks and hollows generally resulting from windthrow on poorly drained soils.

H. Visual Impacts Data. Visual impact assessment conducted for on-site and off-site viewing locations separately (Appendix B, page 14-17). On-site evaluations conducted if a portion of the THO was immediately adjacent to at least one of the six viewing location categories. Off-site evaluations were conducted for those sites that were visible from, but not immediately adjacent to, at least one of the six viewing location categories. All visual impact assessments made under full leaf conditions.

Trail - Well marked, designated or mapped trails.

Stream, River-Watershed greater than 10 square miles - Map obtained from Vermont Agency of Natural Resources.

Designated Natural Area - Natural areas listed in "Natural Areas Department of Forests, Parks and Recreation," September 1984.

Corridor length or size of viewing area - The linear distance on the roadway, trail or stream from which the THO was visible. Size of the viewing area (acres) is the estimated number of acres of the recreation area, designated natural area or designated scenic area from which the THO is visible.

USFS Visual Assessment Categories - The seven categories were based on the definition in National Forest Landscape Management Volume 2, USDA Forest Service Agriculture Handbook 462. The dominant category for THO description was selected. Exceptions were noted. Degree of alteration as observed from the designated viewing location was determined by the amount of contrast resulting from the THO as compared to the existing surrounding landscape. Recently modified areas in the surrounding landscape were noted.

I. Comments - Identified additional characteristics of resources not adequately reflected in the data (Appendix B, page 18).

IV. Map Data - Consists of mapped information from a variety of sources.

A. Soil Survey. Soil surveys from the USDA Soil Conservation Service utilized to determine soil erodability factors (K) for the THO.

B. Rare and Threatened Species. The Vermont Natural Heritage Program of the Agency of Natural Resources will assist in the evaluation of potential impacts. The process for this evaluation consists of two methods. The first method will be to evaluate overlap and/or proximity with mapped communities. The second method will be to evaluate rare and threatened species occurrence potential through land forms and natural communities indicated by topographic maps, aerial photos and possibly some field inspections.

C. Significant Wildlife Habitat. Overlap and proximity of THOs with areas mapped by the Vermont Department of Fish and Wildlife will be conducted. This process is currently being developed.

APPENDIX B:

DATA COLLECTION TALLY FORMS

GENERAL DATA

_____ 1. Operation Number
_____ 2. County: 01=Addison 02=Bennington 03=Caledonia 04=Chittenden 05= Essex 06=Franklin 07=Grand Isle 08=Lamoille 09=Orange 10=Orleans 11=Rutland 12=Washington 13=Windham 14=Windsor
_____ 3. Town_____________________
4. Contact Person Name_________________________
Address_________________________
____
____
Phone ( )_________________________

_____ 5. Interview Person Type: 1=Landowner 2=State forester 3=County forester 4=Fed. forester 5=Ind. forester 6=logger 7=Consultant 8=Other, 9=Unknown, specify___________________
_____ 6. Ownership Type: 1=State 2=Fed 3=Town 4=NIPF 5=Ind 8=Other, 9=Unknown
_____ 7. Prime Obj. for THO: 1=Silv 2=Ag.Conv. 3=Dev 8=Other 9=Unknown

Inspection Date
_____ 8. Month
_____ 9. Day
_____ 10. Year

USGS Map(s)
____
____

_____ 11. Weather past 24 hours: 1=no rain 2=light rain 3=rain 4=heavy rain

Silvicultural Method (% of area within 10%)
____% 12. Clearcutting-Overwood Removal (less than 25% crown closure)
____% 13. Strip Cutting (less than 25% crown closure)
____% 14. Group Selection (patches 1/20-2 acres)
____% 15. Prep. Cut, Seed Cut, Shelt., Seed Tree (25-74% crown closure)
____% 16. Individual Selection/Thinning (+75% crown closure)
____% 17. Other: Specify_________________________
100% Total Notes:_________________________

_____ 18. Size Class Diversity: 1=30+ acres per general size class patch, 2=moderate, 3=5 acre or less per patch
_____ 19. Context Land Use: 1=Forest, 2=Mix Fields/Forest, 3=Predom.Open, 4=Residential, 5=Comm./Ind., 6=Village, 8=Other, 9=Unknown

Wildlife Practices Evident
_____ 20. Apple Release: 1=yes, 2=no
_____ 21. Aspen Regen: 1=yes, 2=no
_____ 22. Mast Production: 1=yes, 2=no
_____ 23. Deer Winter Area Mgmt.: 1=yes, 2=no
_____ 24. Road Daylighting: 1=yes, 2=no
_____ 25. Snag and Den Trees: 1=yes, 2=no

Viewing Location of THO
_____ 26. 1=adjacent only, 2=background only 3=both adjacent and background, 4=neither

INTERVIEW DATA

Operation No. ______

______ 1. Enrolled in UVA at time of THO? 1-yes, 2-no, 9-unknown
______ 2. Wildlife Bio. involv. with planning THO? 1-yes, 2-no, 9-unknown
______ 3. Prof. Forester involv. with THO? 1-yes, 2-no, 9-unknown

How was professional forester involved?
______ 4. Preliminary recon of property-General forest management? 1-yes 2-no, 9-unknown
______ 5. Written Forest Management Plan? 1-yes, 2-no, 9-unknown
______ 6. Marking/Designating timber removal? 1-yes, 2-no, 9-unknown
______ 7. Contract negotiation? 1-yes, 2-no, 9-unknown
______ 8. Skid trail design/layout? 1-yes, 2-no, 9-unknown
______ 9. Landing Designation? 1-yes, 2-no, 9-unknown
______ 10. Sale closeout? 1-yes, 2-no, 9-unknown
______ 11. Forester type? 1-none, 2-state lands, 3-county, 4-consult, 5-federal, 6-industrial, 8-other, 9-Unknown, specify______
______ 12. How trees designated for removal? 1-logger's choice, 2-trees/rows marked, 3-diameter limit, 4-perimeter marked, 8-other, 9-Unknown

______ 13. Felling equipment: 1-mechanized, 2-combination, 3-conventional

Skidding Equipment used
______ 14. Horse? 1-yes, 2-no, 9-unknown
______ 15. Rubber tired skidder? 1-yes, 2-no, 9-unknown
______ 16. Tracked skidder? 1-yes, 2-no, 9-unknown
______ 17. Cable Yarder? 1-yes, 2-no, 9-unknown
______ 18. Other? 1-yes, 2-no, 9-unknown Specify:______

Harvesting Methods
______ 19. Log length? 1-yes, 2-no, 9-unknown
______ 20. Tree length? 1-yes, 2-no, 9-unknown
______ 21. Whole tree? 1-yes, 2-no, 9-unknown

Seasons of THO from start to completion
______ 22. Spring? 1-yes, 2-no, 9-unknown
______ 23. Summer? 1-yes, 2-no, 9-unknown
______ 24. Fall? 1-yes, 2-no, 9-unknown
______ 25. Winter? 1-yes, 2-no, 9-unknown
______ 26. Duration of THO from start to completion? 1-less than one month, 2-1 to 3 months, 3-3+ to 6 months, 4- 6+ to 9 months, 5-9+ months, 9-unknown

Contract contained special provisions for:
______ 27. Archeology/Historical? 1-yes, 2-no, 3-no contract, 9-unknown
______ 28. Threatened/Endangered Species? 1-yes, 2-no, 3-no contr, 9-unknown
______ 29. Water Quality? 1-yes, 2-no, 3-no contract, 9-unknown
______ 30. Aesthetics? 1-yes, 2-no, 3-no contract, 9-unknown
______ 31. Wildlife? 1-yes, 2-no, 3-no contract, 9-unknown

______ 32. Number of landings: 1-1, 2-2, 3-3+, 9-unknown
______ 33. Approximate total acres in THO: 9999-unknown
______ 34. Total contiguous acres in ownership: 9999-unknown

What products were removed during the THO?
______ 35. Firewood, either log length or bucked? 1-yes, 2-no, 9-unknown
______ 36. Hardwood sawlogs? 1-yes, 2-no, 9-unknown
______ 37. Softwood sawlogs? 1-yes, 2-no, 9-unknown
______ 38. Chips? 1-yes, 2-no, 9-unknown
______ 39. Hardwood pulp? 1-yes, 2-no, 9-unknown
______ 40. Softwood pulp? 1-yes, 2-no, 9-unknown
______ 41. Veneer? 1-yes, 2-no, 9-unknown
______ 42. Other? 1-yes, 2-no, 9-unknown Specify______

VEGETATION DATA
(within 2 chains radius of plot center)

Operation No. ______

__1__ 1. Plot number (1 through 6)
_____ 2. Preharvest SAF Type: Name______________________
_____ 3. Preharvest size class: 1-seedling/sapling, 2-poletimber, 3-sawtimber
_____ 4. Residual SAF Type: Name______________________
_____ 5. Site Quality: 1-I, 2-II, 3-III, 4-IV, 9-unknown
_____ 6. Residual size class: 1-seed/sap, 2-pole, 3-saw, 4-non-stocked
_____ 7. Soil drainage: 1-poorly drained, 2-moderately well, 3-well
_____ 8. Slash disposal: 1-removed from site, 2-evenly distributed-tops intact, 3-evenly distributed > 3 feet, 4-evenly distributed < 3 feet, 5-piled/windrowed
_____ 9. Surface characteristics: 1-ledgy,rock outcrops, 2-mod. stony, 3-very stony, 4-sandy, 5-wet, 6-undulating, 7-smooth, 8-other
_____ 10. Plot slope: 1-0-10%, 2-11-20%, 3-21-30%, 4-31-40%, 5-41-50% 6-+50%
_____ 11. Aspect: 1-N, 2-NE, 3-E, 4-SE, 5-S, 6-SW, 7-W, 8-NW, 9-flat
_____ 12. Dominant Silvicultural Method: 1-clearcut, 2-stripcut, 3-group selection, 4-shelterwood, 5-selection/thinning, 8-other:identify
_____ 13. Expected Dominant Vegetation (3-5 years after cutting): 1-none, 2-ferns & herbs, 3-rubus, 4-shrubs, 5-tree coppice, 6-trees, 9-unknown
_____ 14. Expected dominant species composition (3-5 years after cutting): 1-no commercial trees, 2-hemlock, 3-W.Pine, 4-Spruce-fir, 5-other softwood, 6-aspen-w.birch-r.maple, 7-S.Maple-beech-y.birch-ash-bass, 8-other commercial hardwood, 9-mixed hardwood-softwood
_____ 15. Expected dominant reproduction condition (3-5 years after cutting):
1-≤3 ft tall, 0-33% crown closure   4->3 ft tall, 0-33% crown closure
2-≤3 ft tall, 34-66% crown closure   5->3 ft tall, 34-66% crown clos.
3-≤3 ft tall, +66% crown closure   6->3 ft tall, +66% crown closure

BAF 10 - All Tally Trees (as visible from plot center)

Status (S): 1-alive, 2-dead
Canopy Position (CP): 1-dominant-codominant, 2-suppressed
Wildlife (WILD): 1-soft snag, 2-hard snag-cavity, 3-bear use, 9-none
Damage Class: BARK-bark rubbed but intact, SKIN-bark rubbed off, ROOT-exposed, torn or broken, TOP-broken off, tree destroyed BENT-bent over, partially or entirely destroyed

TREE	SPEC	DBH in.	S 12	CP 12	WILD 1239	DAMAGE CLASS (1-YES, 2-NO) BARK 12	SKIN 12	ROOT 12	TOP 12	BENT 12
1										
2										
3										
4										
5										
6										
7										
8										
9										
10										
11										
12										
13										
14										
15										
16										
17										
18										
19										
20										

Soil Impacts (12 foot radius, A and E 66' from plot center, B and D 33' from plot center, and C at plot center)
Forest Floor Condition (FFC) (immediately after THO completion) 1-no bare mineral soil 2-bare mineral soil
Worst Surface Erosion Type (SET): 1-sheet erosion;minute rills occasionally present, 2-rill erosion; rills up to 6 inches deep, 3-limited gully erosion; numerous small gullies 6-12" deep, 4-marked gully erosion; numerous gullies 12-24" deep, 5-advanced erosion, gullies or depressions over 24" deep, 9-no apparent erosion.

Point	FFC 12	SET 123459
A		
B		
C		
D		
E		

VEGETATION DATA
(within 2 chains radius of plot center)

Operation No. ______

__2__ 1. Plot number (1 through 6)
______ 2. Preharvest SAF Type: Name______________________
______ 3. Preharvest size class: 1-seedling/sapling, 2-poletimber, 3-sawtimber
______ 4. Residual SAF Type: Name______________________
______ 5. Site Quality: 1-I, 2-II, 3-III, 4-IV, 9-unknown
______ 6. Residual size class: 1-seed/sap, 2-pole, 3-saw, 4-non-stocked
______ 7. Soil drainage: 1-poorly drained, 2-moderately well, 3-well
______ 8. Slash disposal: 1-removed from site, 2-evenly distributed-tops intact, 3-evenly distributed > 3 feet, 4-evenly distributed < 3 feet, 5-piled/windrowed
______ 9. Surface characteristics: 1-ledgy,rock outcrops, 2-mod. stony, 3-very stony, 4-sandy, 5-wet, 6-undulating, 7-smooth, 8-other
______ 10. Plot slope: 1-0-10%, 2-11-20%, 3-21-30%, 4-31-40%, 5-41-50% 6-+50%
______ 11. Aspect: 1-N, 2-NE, 3-E, 4-SE, 5-S, 6-SW, 7-W, 8-NW, 9-flat
______ 12. Dominant Silvicultural Method: 1-clearcut, 2-stripcut, 3-group selection, 4-shelterwood, 5-selection/thinning, 8-other:identify
______ 13. Expected Dominant Vegetation (3-5 years after cutting): 1-none, 2-ferns & herbs, 3-rubus, 4-shrubs, 5-tree coppice, 6-trees, 9-unknown
______ 14. Expected dominant species composition (3-5 years after cutting): 1-no commercial trees, 2-hemlock, 3-W.Pine, 4-Spruce-fir, 5-other softwood, 6-aspen-w.birch-r.maple, 7-S.Maple-beech-y.birch-ash-bass, 8-other commercial hardwood, 9-mixed hardwood-softwood
______ 15. Expected dominant reproduction condition (3-5 years after cutting):
1-≤3 ft tall, 0-33% crown closure   4->3 ft tall, 0-33% crown closure
2-≤3 ft tall, 34-66% crown closure   5->3 ft tall, 34-66% crown clos.
3-≤3 ft tall, +66% crown closure   6->3 ft tall, +66% crown closure

BAF 10 - All Tally Trees (as visible from plot center)

Status (S): 1-alive, 2-dead
Canopy Position (CP): 1-dominant-codominant, 2-suppressed
Wildlife (WILD): 1-soft snag, 2-hard snag-cavity, 3-bear use, 9-none
Damage Class: BARK-bark rubbed but intact, SKIN-bark rubbed off, ROOT-exposed, torn or broken, TOP-broken off, tree destroyed BENT-bent over, partially or entirely destroyed

						DAMAGE CLASS (1-YES, 2-NO)				
TREE	SPEC	DBH in.	S 12	CP 12	WILD 1239	BARK 12	SKIN 12	ROOT 12	TOP 12	BENT 12
1										
2										
3										
4										
5										
6										
7										
8										
9										
10										
11										
12										
13										
14										
15										
16										
17										
18										
19										
20										

Soil Impacts (12 foot radius, A and E 66' from plot center, B and D 33' from plot center, and C at plot center)
Forest Floor Condition (FFC) (immediately after THO completion) 1-no bare mineral soil 2-bare mineral soil
Worst Surface Erosion Type (SET): 1-sheet erosion;minute rills occasionally present, 2-rill erosion; rills up to 6 inches deep, 3-limited gully erosion; numerous small gullies 6-12" deep, 4-marked gully erosion; numerous gullies 12-24" deep, 5-advanced erosion, gullies or depressions over 24" deep, 9-no apparent erosion.

Point	FFC 12	SET 123459
A		
B		
C		
D		
E		

VEGETATION DATA
(within 2 chains radius of plot center)

Operation No. ____

3 1. Plot number (1 through 6)
____ 2. Preharvest SAF Type: Name____
____ 3. Preharvest size class: 1-seedling/sapling, 2-poletimber, 3-sawtimber
____ 4. Residual SAF Type: Name____
____ 5. Site Quality: 1-I, 2-II, 3-III, 4-IV, 9-unknown
____ 6. Residual size class: 1-seed/sap, 2-pole, 3-saw, 4-non-stocked
____ 7. Soil drainage: 1-poorly drained, 2-moderately well, 3-well
____ 8. Slash disposal: 1-removed from site, 2-evenly distributed-tops intact, 3-evenly distributed > 3 feet, 4-evenly distributed < 3 feet, 5-piled/windrowed
____ 9. Surface characteristics: 1-ledgy,rock outcrops, 2-mod. stony, 3-very stony, 4-sandy, 5-wet, 6-undulating, 7-smooth, 8-other
____ 10. Plot slope: 1-0-10%, 2-11-20%, 3-21-30%, 4-31-40%, 5-41-50% 6-+50%
____ 11. Aspect: 1-N, 2-NE, 3-E, 4-SE, 5-S, 6-SW, 7-W, 8-NW, 9-flat
____ 12. Dominant Silvicultural Method: 1-clearcut, 2-stripcut, 3-group selection, 4-shelterwood, 5-selection/thinning, 8-other:identify
____ 13. Expected Dominant Vegetation (3-5 years after cutting): 1-none, 2-ferns & herbs, 3-rubus, 4-shrubs, 5-tree coppice, 6-trees, 9-unknown
____ 14. Expected dominant species composition (3-5 years after cutting): 1-no commercial trees, 2-hemlock, 3-W.Pine, 4-Spruce-fir, 5-other softwood, 6-aspen-w.birch-r.maple, 7-S.Maple-beech-y.birch-ash-bass, 8-other commercial hardwood, 9-mixed hardwood-softwood
____ 15. Expected dominant reproduction condition (3-5 years after cutting):
1-≤3 ft tall, 0-33% crown closure 4->3 ft tall, 0-33% crown closure
2-≤3 ft tall, 34-66% crown closure 5->3 ft tall, 34-66% crown clos.
3-≤3 ft tall, +66% crown closure 6->3 ft tall, +66% crown closure

BAF 10 - All Tally Trees (as visible from plot center)

Status (S): 1-alive, 2-dead
Canopy Position (CP): 1-dominant-codominant, 2-suppressed
Wildlife (WILD): 1-soft snag, 2-hard snag-cavity, 3-bear use, 9-none
Damage Class: BARK-bark rubbed but intact, SKIN-bark rubbed off, ROOT-exposed, torn or broken, TOP-broken off, tree destroyed BENT-bent over, partially or entirely destroyed

TREE	SPEC	DBH in.	S 12	CP 12	WILD 1239	DAMAGE CLASS (1-YES, 2-NO) BARK 12	SKIN 12	ROOT 12	TOP 12	BENT 12
1										
2										
3										
4										
5										
6										
7										
8										
9										
10										
11										
12										
13										
14										
15										
16										
17										
18										
19										
20										

Soil Impacts (12 foot radius, A and E 66' from plot center, B and D 33' from plot center, and C at plot center)
Forest Floor Condition (FFC) (immediately after THO completion) 1-no bare mineral soil 2-bare mineral soil
Worst Surface Erosion Type (SET): 1-sheet erosion;minute rills occasionally present, 2-rill erosion; rills up to 6 inches deep, 3-limited gully erosion; numerous small gullies 6-12" deep, 4-marked gully erosion; numerous gullies 12-24" deep, 5-advanced erosion, gullies or depressions over 24" deep, 9-no apparent erosion.

Point	FFC 12	SET 123459
A		
B		
C		
D		
E		

VEGETATION DATA
(within 2 chains radius of plot center)

Operation No. ______

4 1. Plot number (1 through 6)
____ 2. Preharvest SAF Type: Name____________________
____ 3. Preharvest size class: 1-seedling/sapling, 2-poletimber, 3-sawtimber
____ 4. Residual SAF Type: Name____________________
____ 5. Site Quality: 1-I, 2-II, 3-III, 4-IV, 9-unknown
____ 6. Residual size class: 1-seed/sap, 2-pole, 3-saw, 4-non-stocked
____ 7. Soil drainage: 1-poorly drained, 2-moderately well, 3-well
____ 8. Slash disposal: 1-removed from site, 2-evenly distributed-tops intact, 3-evenly distributed > 3 feet, 4-evenly distributed < 3 feet, 5-piled/windrowed
____ 9. Surface characteristics: 1-ledgy,rock outcrops, 2-mod. stony, 3-very stony, 4-sandy, 5-wet, 6-undulating, 7-smooth, 8-other
____ 10. Plot slope: 1-0-10%, 2-11-20%, 3-21-30%, 4-31-40%, 5-41-50% 6-+50%
____ 11. Aspect: 1-N, 2-NE, 3-E, 4-SE, 5-S, 6-SW, 7-W, 8-NW, 9-flat
____ 12. Dominant Silvicultural Method: 1-clearcut, 2-stripcut, 3-group selection, 4-shelterwood, 5-selection/thinning, 8-other:identify
____ 13. Expected Dominant Vegetation (3-5 years after cutting): 1-none, 2-ferns & herbs, 3-rubus, 4-shrubs, 5-tree coppice, 6-trees, 9-unknown
____ 14. Expected dominant species composition (3-5 years after cutting): 1-no commercial trees, 2-hemlock, 3-W.Pine, 4-Spruce-fir, 5-other softwood, 6-aspen-w.birch-r.maple, 7-S.Maple-beech-y.birch-ash-bass, 8-other commercial hardwood, 9-mixed hardwood-softwood
____ 15. Expected dominant reproduction condition (3-5 years after cutting):
1-≤3 ft tall, 0-33% crown closure   4->3 ft tall, 0-33% crown closure
2-≤3 ft tall, 34-66% crown closure   5->3 ft tall, 34-66% crown clos.
3-≤3 ft tall, +66% crown closure   6->3 ft tall, +66% crown closure

BAF 10 - All Tally Trees (as visible from plot center)

Status (S): 1-alive, 2-dead
Canopy Position (CP): 1-dominant-codominant, 2-suppressed
Wildlife (WILD): 1-soft snag, 2-hard snag-cavity, 3-bear use, 9-none
Damage Class: BARK-bark rubbed but intact, SKIN-bark rubbed off,
ROOT-exposed, torn or broken, TOP-broken off, tree destroyed
BENT-bent over, partially or entirely destroyed

TREE	SPEC	DBH in.	S 12	CP 12	WILD 1239	DAMAGE CLASS (1-YES, 2-NO) BARK 12	SKIN 12	ROOT 12	TOP 12	BENT 12
1										
2										
3										
4										
5										
6										
7										
8										
9										
10										
11										
12										
13										
14										
15										
16										
17										
18										
19										
20										

Soil Impacts (12 foot radius, A and E 66' from plot center, B and D 33' from plot center, and C at plot center)
Forest Floor Condition (FFC) (immediately after THO completion) 1-no bare mineral soil 2-bare mineral soil
Worst Surface Erosion Type (SET): 1-sheet erosion;minute rills occasionally present, 2-rill erosion; rills up to 6 inches deep, 3-limited gully erosion; numerous small gullies 6-12" deep, 4-marked gully erosion; numerous gullies 12-24" deep, 5-advanced erosion, gullies or depressions over 24" deep, 9-no apparent erosion.

Point	FFC 12	SET 123459
A		
B		
C		
D		
E		

(Within 2 chains radius of plot center)

_5_ 1. Plot number (1 through 6)
___ 2. Preharvest SAF Type: Name__________
___ 3. Preharvest size class: 1-seedling/sapling, 2-poletimber, 3-sawtimber
___ 4. Residual SAF Type: Name__________
___ 5. Site Quality: 1-I, 2-II, 3-III, 4-IV, 9-unknown
___ 6. Residual size class: 1-seed/sap, 2-pole, 3-saw, 4-non-stocked
___ 7. Soil drainage: 1-poorly drained, 2-moderately well, 3-well
___ 8. Slash disposal: 1-removed from site, 2-evenly distributed-tops intact, 3-evenly distributed > 3 feet, 4-evenly distributed < 3 feet, 5-piled/windrowed
___ 9. Surface characteristics: 1-ledgy,rock outcrops, 2-mod. stony, 3-very stony, 4-sandy, 5-wet, 6-undulating, 7-smooth, 8-other
___ 10. Plot slope: 1-0-10%, 2-11-20%, 3-21-30%, 4-31-40%, 5-41-50% 6-+50%
___ 11. Aspect: 1-N, 2-NE, 3-E, 4-SE, 5-S, 6-SW, 7-W, 8-NW, 9-flat
___ 12. Dominant Silvicultural Method: 1-clearcut, 2-stripcut, 3-group selection, 4-shelterwood, 5-selection/thinning, 8-other:identify
___ 13. Expected Dominant Vegetation (3-5 years after cutting): 1-none, 2-ferns & herbs, 3-rubus, 4-shrubs, 5-tree coppice, 6-trees, 9-unknown
___ 14. Expected dominant species composition (3-5 years after cutting): 1-no commercial trees, 2-hemlock, 3-W.Pine, 4-Spruce-fir, 5-other softwood, 6-aspen-w.birch-r.maple, 7-S.Maple-beech-y.birch-ash-bass, 8-other commerical hardwood, 9-mixed hardwood-softwood
___ 15. Expected dominant reproduction condition (3-5 years after cutting):
1-≤3 ft tall, 0-33% crown closure 4->3 ft tall, 0-33% crown closure
2-≤3 ft tall, 34-66% crown closure 5->3 ft tall, 34-66% crown clos.
3-≤3 ft tall, +66% crown closure 6->3 ft tall, +66% crown closure

___

BAF 10 - All Tally Trees (as visible from plot center)

Status (S): 1-alive, 2-dead
Canopy Position (CP): 1-dominant-codominant, 2-suppressed
Wildlife (WILD): 1-soft snag, 2-hard snag-cavity, 3-bear use, 9-none
Damage Class: BARK-bark rubbed but intact, SKIN-bark rubbed off, ROOT-exposed, torn or broken, TOP-broken off, tree destroyed BENT-bent over, partially or entirely destroyed

TREE	SPEC	DBH in.	S 12	CP 12	WILD 1239	DAMAGE CLASS (1-YES, 2-NO) BARK 12	SKIN 12	ROOT 12	TOP 12	BENT 12
1										
2										
3										
4										
5										
6										
7										
8										
9										
10										
11										
12										
13										
14										
15										
16										
17										
18										
19										
20										

Soil Impacts (12 foot radius, A and E 66' from plot center, B and D 33' from plot center, and C at plot center)
Forest Floor Condition (FFC) (immediately after THO completion) 1-no bare mineral soil 2-bare mineral soil
Worst Surface Erosion Type (SET): 1-sheet erosion;minute rills occasionally present, 2-rill erosion; rills up to 6 inches deep, 3-limited gully erosion; numerous small gullies 6-12" deep, 4-marked gully erosion; numerous gullies 12-24" deep, 5-advanced erosion, gullies or depressions over 24" deep, 9-no apparent erosion.

Point	FFC 12	SET 123459
A		
B		
C		
D		
E		

(Within 2 chains radius of plot center) Operation No: ______

6 1. Plot number (1 through 6)
_____ 2. Preharvest SAF Type: Name_____
_____ 3. Preharvest size class: 1-seedling/sapling, 2-poletimber, 3-sawtimber
_____ 4. Residual SAF Type: Name_____
_____ 5. Site Quality: 1-I, 2-II, 3-III, 4-IV, 9-unknown
_____ 6. Residual size class: 1-seed/sap, 2-pole, 3-saw, 4-non-stocked
_____ 7. Soil drainage: 1-poorly drained, 2-moderately well, 3-well
_____ 8. Slash disposal: 1-removed from site, 2-evenly distributed-tops intact, 3-evenly distributed > 3 feet, 4-evenly distributed < 3 feet, 5-piled/windrowed
_____ 9. Surface characteristics: 1-ledgy,rock outcrops, 2-mod. stony, 3-very stony, 4-sandy, 5-wet, 6-undulating, 7-smooth, 8-other
_____ 10. Plot slope: 1-0-10%, 2-11-20%, 3-21-30%, 4-31-40%, 5-41-50% 6-+50%
_____ 11. Aspect: 1-N, 2-NE, 3-E, 4-SE, 5-S, 6-SW, 7-W, 8-NW, 9-flat
_____ 12. Dominant Silvicultural Method: 1-clearcut, 2-stripcut, 3-group selection, 4-shelterwood, 5-selection/thinning, 8-other:identify
_____ 13. Expected Dominant Vegetation (3-5 years after cutting): 1-none, 2-ferns & herbs, 3-rubus, 4-shrubs, 5-tree coppice, 6-trees, 9-unknown
_____ 14. Expected dominant species composition (3-5 years after cutting): 1-no commercial trees, 2-hemlock, 3-W.Pine, 4-Spruce-fir, 5-other softwood, 6-aspen-w.birch-r.maple, 7-S.Maple-beech-y.birch-ash-bass, 8-other commercial hardwood, 9-mixed hardwood-softwood
_____ 15. Expected dominant reproduction condition (3-5 years after cutting):
1-≤3 ft tall, 0-33% crown closure 4->3 ft tall, 0-33% crown closure
2-≤3 ft tall, 34-66% crown closure 5->3 ft tall, 34-66% crown clos.
3-≤3 ft tall, +66% crown closure 6->3 ft tall, +66% crown closure

BAF 10 - All Tally Trees (as visible from plot center)

Status (S): 1-alive, 2-dead
Canopy Position (CP): 1-dominant-codominant, 2-suppressed
Wildlife (WILD): 1-soft snag, 2-hard snag-cavity, 3-bear use, 9-none
Damage Class: BARK-bark rubbed but intact, SKIN-bark rubbed off, ROOT-exposed, torn or broken, TOP-broken off, tree destroyed BENT-bent over, partially or entirely destroyed

TREE	SPEC	DBH in.	S 12	CP 12	WILD 1239	DAMAGE CLASS (1-YES, 2-NO) BARK 12	SKIN 12	ROOT 12	TOP 12	BENT 12
1										
2										
3										
4										
5										
6										
7										
8										
9										
10										
11										
12										
13										
14										
15										
16										
17										
18										
19										
20										

Soil Impacts (12 foot radius, A and E 66' from plot center, B and D 33' from plot center, and C at plot center)
Forest Floor Condition (FFC) (immediately after THO completion) 1-no bare mineral soil 2-bare mineral soil
Worst Surface Erosion Type (SET): 1-sheet erosion;minute rills occasionally present, 2-rill erosion; rills up to 6 inches deep, 3-limited gully erosion; numerous small gullies 6-12" deep, 4-marked gully erosion; numerous gullies 12-24" deep, 5-advanced erosion, gullies or depressions over 24" deep, 9-no apparent erosion.

Point	FFC 12	SET 123459
A		
B		
C		
D		
E		

... any crossings in sale area) Operation No. ______

______ Any observations of stream crossings in THO area: 1-yes, 2-no

Road Type (ROAD): 1-permanent truck, 2-temporary truck, 3-skid road
Stream Type (STREAM): 1-permanent, 2-intermittent
Crossing Type (CROSS): 1-metal culvert, 2-wooden culvert, 3-ford, 4-bridge, 5-log ford, 6-brush, 7-other 8-removed
Functional Structure Size (FSS) - square feet (For Cross 1, 2 & 4 only)
Minimum Structure Size (MSS) - square feet hasty method (For Cross 1, 2 & 4 only) $[(W_1 + W_2)/2]\ H$
Acute Angle of Crossing (ANGLE): 1-80-90, 2-60-79, 3-less than 60
Soil seeded and mulched? (SEED): 1-yes, 2-no, 9-unknown
Streambed and approach stability (STABLE): 1-yes, 2-no
Turnups or BBD before crossing? (BBD): 1-yes, 2-no
Sedimentation Evidence within 1 chain (SED): 1-natural, 2-thinly coated streambed, 3-plumes, thick deposits
Slash and Woody Debris within 1 chain (DEBRIS): 1-natural, 2-moderate, 3-blocking or altering stream flow
Petroleum (OIL): 1-yes, 2-no

PT	ROAD 123	STREAM 1 2	CROSS 1 - 8	FSS	MSS	ANGLE 1 2 3	SEED 1 2 9	STABLE 1 2	BBD 1 2	SED 123	DEBRIS 1 2 3	OIL 1 2
1												
2												
3												
4												
5												
6												
7												

TRUCK ROAD AND SKID TRAIL DATA

Operation No. ______

Functioning Drainage Structures (FDS)-number in the road segment
Recommended Drainage Structures (RDS)-number suggested in AMP's
Protective Strip Width (PSW) 1-<50', 2-50', 3-70', 4-90', 5-110', 6-130', 7->130' or no stream visible, 8-stream crossing
Recommended Strip Width (RSW): 1-<50', 2-50', 3-70', 4-90', 5-110', 6-130', 7->130' or no stream visible, 8-stream crossing
Silt Fencing and Haybale Checks (CHECKS)-found in segment: 1-yes, 2-no
Surface Erosion Type (SET)-worst type in last segment: 1-sheet, minute rills present, 2-rill, rills up to 6" deep, 3-initial gully, many gullies 6-12" deep, 4-marked gully erosion, 12-24" deep, 5-advanced +24" deep, 9-no apparent erosion.
Soil Drainage (DRAIN): 1-poorly drained, 2- mod. well drained, 3-well
Grade (GRADE)-last three chains measured or best estimate, in percent
Segments +300 feet (STEEP)-truck roads over 10%, skid trails over 20%: 1-yes, 2-no

Skid Trail Exam-from "main" landing select main skid road to end of harvest or 1/3 mile whichever is less. First point 1.5 chains from landing and 3 chains thereafter.

Point #	FDS	RDS	PSW	RSW	CHECKS 1 2	SET 123459	DRAIN 1 2 3	GRADE %	STEEP 1 2
1									
2									
3									
4									
5									
6									
7									
8									
9									

Truck Road Exam- examine road from landings to public road or 1/2 mile whichever is less. First point 2 chains from landing and 8 chains thereafter. If less than 2 chains, consider part of landing.

______ Truck Road Type (TRT): 1-permanent, 2-temporary

Point #	FDS	RDS	PSW	RSW	CHECKS 1 2	SET 123459	DRAIN 1 2 3	GRADE %	STEEP 1 2
1									
2									
3									
4									
5									
6									

Landing Number (LAND)
Size of landing (SIZE) - in acres
Slope of landing (SLOPE): 1-0-5%, 2-6-15%, 3-+15%
Landing in Protective Strip? (STRIP): 1-yes, 2-no
Petroleum Spills (OIL): 1-yes, 2-no evidence of spills
Graded and Diversions Installed? (G/D): 1-yes, 2-no
Soil Drainage (DRAIN): 1-poorly, 2-moderately well drained, 3-well drained
Seeded and mulched (SEED): 1-yes, 2-no, 9-unknown
Surface Erosion Type (SET): 1-sheet, minute rills present, 2-rill, rills up to 6" deep, 3-initial gully 6-12" deep, 4-marked gully 12-24" deep, 5-advanced gully +24" deep, 9-none to slight.

LAND	SIZE ac.	SLOPE 1 2 3	STRIP 1 2	OIL 1 2	G/D 1 2	DRAIN 1 2 3	SET 123459	SEED 1 2 9
1								
2								
3								
4								

STREAM AND SURFACE WATER DATA

Operation No. ______

Select that stream or water body that could be most heavily impacted by the THO. For selected stream or waterbody, place point 1 at an elevation just below the THO and examine the stream or waterbody at 4 chain intervals to end or 1/2 mile whichever is less.

_____ 1. Water Body Type: 1-intermittent stream, 2-permanent stream/river, 3-lake, 4-pond, 5-wetland, 6-other, 7-none

Fill out for Streams and Rivers

_____ 2. Length of stream examined (CHAINS), 99-None
_____ 3. Turbidity above THO (NTU), 999-Not Taken
_____ 4. Turbidity below THO (NTU), 999-Not Taken
_____ 5. Water temp above THO (°C), 99-Not Taken
_____ 6. Water temp below THO (°C), 99-Not Taken
_____ 7. Water temp at highest point in THO (°C), 99-Not Taken

Protective Strip Canopy Condition (PSCC): 1-no apparent change, 2-light thinnings, continuous cover maintained, 3-large openings created, continuous cover not maintained.
Dominant Condition (COND): 1-natural condition, clean adj. rocks, stable, little sediment natural location, no plumes, no alluvial fans
2-moderate
3-adj. rocks coated, active bank cutting, heavy sedimentation, stream relocated, many plumes & alluvial fans
Buffer Strip Entries (25'), (BSE): excluding skid and truck road crossings - number
Stream Crossings (XING): number of skid trail or road crossings
Debris (DEB) - number of tops/logging debris in streambed or waterbody
Skidding in Streams (SKID): 1-yes, 2-no

POINT #	PSCC 1 2 3	COND 1 2 3	BSE #	XING #	DEB #	SKID 1 2
1						
2						
3						
4						
5						
6						
7						
8						
9						
10						

Locate each substantial site by number on the topo map (eg.H1)
_____ Any observations of historic sites within the THO? 1-yes, 2-no
Site Number (NUMBER)
Site Component (COMP): 1-house foundation or building depression
2-outbuilding foundation or depression
3-dams and mill foundations
4-pens in vicinity of res. area
5-farm roads if adjacent to above
6-rock alignment or dep., origin unknown
7-stone walls
8-shack, collapsed or otherwise
9-other: describe_____
Descriptive notes for unusual sites_____

Nature/Severity of Impact: 1-at or within 20 feet
2-within 100 feet
3-not within 100 feet
TRUCK-truck road, SKID-skid trail, LAND-log landing
EROSION-major/substantial erosion, RUTTING-substantial rutting
COMPONENT IMPACT: 1-breached 2-filled/rearranged, 3-avoided
4-other:describe_____

Number	Comp	Nature/Severity of Impact					Comp. Impact
		Truck	Skid	Land	Erosion	Rutting	
	1-9	1 2 3	1 2 3	1 2 3	1 2 3	1 2 3	1 2 3 4
H 1							
H 2							
H 3							
H 4							
H 5							
H 6							
H 7							

_____ PERCENTAGE of THO observed (OBSER) for Historic Sites
1-<20%; 2-21-40%; 3-41-60%; 4-61-80%; 5-81-100%; 9-Unknown

--

POTENTIAL PREHISTORIC SITES DATA
(throughout the timber harvest area)
Locate each site by number on the topographic map (ex.A 2)

Operation No. _____

_____ Any observtions of potential prehistoric sites within the THO?
1-yes, 2-no

Sites must be all of the following:
1. Within 100 feet of stream or obvious relic drainage AND
2. a terrace with a slope of less than or equal to % 5 AND
3. flat or with south to west aspect

Terrace Type (TERRACE): 1-outwash plain, 2-alluvial

Pit Mounds (PITMOUND): 1-none, 2-occasional, 3-extensive

Terrace Impact Activity (ACTIVITY): 1-trail/road, 2-landing, 3-both, 9-none

Disturbance (DISTURBANCE): 1-obvious activity, obvious erosion point specific disturbance, 2-limited surface disturbance with occasional depressions, 3-no disturbance observed.

SITE #	TERRACE	PITMOUND	ACTIVITY	DISTURBANCE
	1 2	1 2 3	1 2 3 9	1 2 3
A 1				
A 2				
A 3				
A 4				
A 5				
A 6				
A 7				
A 8				

Site Description:_____

_____ Prominant Rock Exposure (i.e. Cheshire and Crystal.Quartz) over 30 feet long. If located, assign number on map (ex. R-1)
1-yes, without major site disturbance
2-yes, with major site disturbance
3-no prominent rock exposure observed

VISUAL IMPACTS DATA Operation No. ______

Viewing Location of THO: 1=adjacent only, 2=background only
3=both adjacent and background, 4=none

Photograph
from:

Paved Public Roadway (Name, if known)
______ ______ Local (Name________________________________)
______ ______ State (Name________________________________)
______ ______ Interstate (Name___________________________)
Public Recreation Area (Name, if known)
______ ______ Local (Name________________________________)
______ ______ State (Name________________________________)
______ ______ Federal (Name______________________________)
Trail (Name, if known)
______ ______ Hiking (Name_______________________________)
______ ______ Bicycle (Name______________________________)
______ ______ Bridle (Name_______________________________)
______ ______ X-C Ski (Name______________________________)
Stream, River, Pond, Lake (Name, if known)
______ ______ Stream, River-watershed greater than 10 square miles
______ ______ Lake, Pond-greater than 25 acres (Name_________________)
Designated Natural Area (Name, if known)
______ ______ Natural Area (Name_______________________)
Designated Scenic Area (Name, if known)
______ ______ Scenic Area (Name________________________)

On Site Data Collection -- answer only if "1" or "3" filled on page VI-1. If visible from 2 or more, select the two most prominent areas. If impact will be long term, indicate such in the notes and specify. Long term is defined as equal to or greater than 5 years. Indicate location on topo map (ex. V-1).

V1 Point Number (Location______________________)

HARVESTING (include landings and roads)

___ Size of openings: ______________________
1-cut incr. spacing trees, openings 1-3 ac., <25% open
2-small openings, added diversity, 3-8 ac., 25-50% open
3-clearing dominates view, >8 ac. openings >50% open

___ Edge Transition: ______________________
1-gradual, feathering of shrub to tall tree layer
2-variation between extremes along cut line
3-abrupt transition esp. to wall of tall trees, dead br.

___ Edge Configuration: ______________________
2-no edge, irregular edge
3-straight edge along cut line

___ Horizon line: ______________________
2-horizon line uncut
3-horizon line cut

___ Stumps:
1-low, less than 1 foot, difficult to see
2-few stumps over 1 foot high visible
3-numerous stumps over 1 foot high visible

___ Slash and Debris: ______________________
1-slash non existent or consistent with natural slash
2-close to ground or +200 feet from viewer, gone in 2 yrs.
3-left where it falls, large trunks and limbs dom. scene

___ Exposed earth: ______________________
1-no exposed earth
2-occasional glimpses but appears veg. will quickly estab
3-exposed earth very visible

___ Views: ______________________
1-positive views revealed by cut (eg. hills, valley, etc.)
2-no new views
3-negative view exposed by cut (eg. transmission line)

RESIDUAL STAND

___ Visible from viewing point (1-yes, 2-no)______________

___ Spacing between trees: ______________________
1-thinning to remove smaller, poor quality trees TSI
2-groups of trees remain in openings SHELTERWOOD
3-clear cut

___ Size of trees: ______________________
1-trees remaining are predominantly sawtimber
2-trees remaining are predominantly pole sized
3-trees remaining are predominantly seedling, saplings

___ Health of residual stand: ______________________
1-no wounds evident, trees appear healthy
2-occasional wounds, mixture of healthy, diseased trees
3-wounds abundant, remaining trees generally unhealthy

ROADS

___ Visible: ______________________
1-yes, 2-no

___ Exposed earth on cut and fill slopes: ______________
1-lush vegetation up to travel surface of road
2-occasional areas of exposed earth, will grow in soon
3-large areas of exposed earth visible on roadside edges

___ Size: ______________________
1-narrow (10-12 feet)
2-average (12-18 feet)
3-greater than 18 feet, offset tracks abundant

___ Alignment: ______________________
1-road curves out of sight shortly, designed with contours
2-generally well designed but visually dominant
3-long straight stretches, designed against contours

___ Public Access: ______________________
1-new public access
2-no new public access

WETLANDS

___ Visible: ______________________
1-yes, 2-no

___ Slash: ______________________
2-no slash
3-slash left in or near stream channels or other wetland

___ Buffer: ______________________
1-buffer remains between harvested area and wetland
3-no buffer

___ Access: ______________________
1-new or improved public access to wetland
2-no access

___ View of wetland: ______________________
1-view improved
2-no view
3-view damaged or eliminated

On Site Data Collection -- answer only if "1" or "3" filled on page VI-1. If visible from 2 or more, select the two most prominent areas. If impact will be long term, indicate such in the notes and specify. Long term is defined as equal to or greater than 5 years. Indicate location on topo map (ex. V-1).

V2 Point Number (Location________________________)

HARVESTING (include landings and roads)

___ Size of openings: ________________________
1-cut incr. spacing trees, openings 1-3 ac., <25% open
2-small openings, added diversity, 3-8 ac., 25-50% open
3-clearing dominates view, >8 ac. openings >50% open

___ Edge Transition: ________________________
1-gradual, feathering of shrub to tall tree layer
2-variation between extremes along cut line
3-abrupt transition esp. to wall of tall trees, dead br.

___ Edge Configuration: ________________________
2-no edge, irregular edge
3-straight edge along cut line

___ Horizon lline: ________________________
2-horizon line uncut
3-horizon line cut

___ Stumps:
1-low, less than 1 foot, difficult to see
2-few stumps over 1 foot high visible
3-numerous stumps over 1 foot high visible

___ Slash and Debris: ________________________
1-slash non existent or consistent with natural slash
2-close to ground or +200 feet from viewer, gone in 2 yrs.
3-left where it falls, large trunks and limbs dom. scene

___ Exposed earth: ________________________
1-no exposed earth
2-occasional glimpses but appears veg. will quickly estab
3-exposed earth very visible

___ Views: ________________________
1-positive views revealed by cut (eg. hills, valley, etc.)
2-no new views
3-negative view exposed by cut (eg. transmission line)

RESIDUAL STAND

___ Visible from viewing point (1-yes, 2-no)________________
___ Spacing between trees: ________________________
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2-groups of trees remain in openings SHELTERWOOD
3-clear cut

___ Size of trees: ________________________
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2-trees remaining are predominantly pole sized
3-trees remaining are predominantly seedling, saplings

___ Health of residual stand: ________________________
1-no wounds evident, trees appear healthy
2-occasional wounds, mixture of healthy, diseased trees
3-wounds abundant, remaining trees generally unhealthy

ROADS

___ Visible: ________________________
1-yes, 2-no

___ Exposed earth on cut and fill slopes: ________________
1-lush vegetation up to travel surface of road
2-occasional areas of exposed earth, will grow in soon
3-large areas of exposed earth visible on roadside edges

___ Size: ________________________
1-narrow (10-12 feet)
2-average (12-18 feet)
3-greater than 18 feet, offset tracks abundant

___ Alignment: ________________________
1-road curves out of sight shortly, designed with contours
2-generally well designed but visually dominant
3-long straight stretches, designed against contours

___ Public Access: ________________________
1-new public access
2-no new public access

WETLANDS

___ Visible: ________________________
1-yes, 2-no

___ Slash: ________________________
2-no slash
3-slash left in or near stream channels or other wetland

___ Buffer: ________________________
1-buffer remains between harvested area and wetland
3-no buffer

___ Access: ________________________
1-new or improved public access to wetland
2-no access

___ View of wetland: ________________________
1-view improved
2-no view
3-view damaged or eliminated

VISUAL IMPACTS DATA

Operation No. ______

Off site data collection (answer only if numbers "2" and "3" were used in "Viewing Location of the Timber Harvesting Operation on page VI-1)

General Information View Points (list)	Corridor length or size of viewing area	Area of THO visible (acres)
B-1		
B-2		
B-3		
B-4		
B-5		
B-6		
B-7		
B-8		

Off site visual impact assessment. If the cut is visible from more than one point or area, collect data from two readily accessible areas from which the THO is most visible. Indicate location of off site point on topo. (ex. B-1)

B-__ B-__ Off site point number
Harvest Characteristics

____ ____ Configuration: 2=can't be seen-no openings; 3=shape of opening reflects natural features (Topo, nearby meadows); 4=rectangular edges but modified by topography, existing trees, etc.; 5=strong contrast with surrounding landscape

____ ____ Size: 2=can't be seen, 3=small area visible, 4=visible but not dominant, 5=very large area, dominant

____ ____ Cut line (edge): 2=can't be seen, 3=feathered, 4=combination, 5=abrupt

____ ____ Horizon Line: 2=can't be seen, 3=trees remain on horizon line, 4=small, feathered cut, cut near horizon line, 5=visible

____ ____ View: 1=improves view, 2=no new views, 4=partial view of feature incongruous with setting, 5=wide open view to unpleasant site

____ ____ Overall Rating: 1=improved, 2=none, 3=minimal, 4=moderate, 5=severe

____ ____ USFS's Visual Assessment Categories
1=Enhancement, 2=Preservation, 3=Retention, 4=Partial Retention, 5=Modification, 6=Max. Modification, 7=Unacceptable Modification

B- ____ Notes: ______________________________
____

B- ____ Notes: ______________________________
____

COMMENTS

Operation No. ______

GENERAL:

WILDLIFE:

WATER QUALITY:

AESTHETICS:

HISTORICAL/ARCHEOLOGICAL:

VEGETATION:

OTHER:

APPENDIX C:

Management Practices to Mitigate Negative Visual Impacts of Timber Harvesting Operations

MANAGEMENT PRACTICES TO MITIGATE NEGATIVE VISUAL IMPACTS OF TIMBER HARVESTING OPERATIONS

This section will be divided into three sections: (1) basic aesthetic value principles, (2) identifying areas sensitive to negative visual impacts, and (3) guidelines for minimizing negative visual impacts of timber harvesting operations.

1. Basic Aesthetic Value Principles

   a) As New England becomes increasingly developed, Vermont's importance as a place of recreational opportunities, open space, and landscape beauty has become more valuable. Forest lands are critical resources as they are used increasingly by hunters, hikers, snowmobilers, skiers, horseback riders, and others for a range of other activities. It would seem to be in the interest of all landowners and all Vermonters to manage forests not just for their timber value, but for their recreational, scenic, and wildlife values as well. A more holistic or multi-purpose approach to silviculture would undoubtedly improve aesthetic values and should certainly be encouraged. Consideration should also be given to managing for old-age stands, especially on public lands.

   b) In minimizing negative visual impacts, it is important to understand the difference between *designing a cut* and *buffering a cut.* Buffering a cut, i.e., leaving trees between a public viewing area and the cut, is a technique that works well in some instances, particularly when the cut is immediately adjacent to the viewer and at the same level. It does not work well on cuts that occur on hillsides or on cuts seen at a distance as they are often seen from many vantage points. A well designed cut, one that fits in well with its surroundings, need not be hidden. Forestry is a part of the Vermont landscape, and as one state forester said, "People who live in wood houses should see stumps." But slash and spindly, leaning trees that are visible to the public are perceived as indicators of poor housekeeping and poor stewardship of the land. Designing a cut that retains the scenic values of the landscape takes little effort. Some simple guidelines are suggested below (Section 3).

2. Identifying areas that will be sensitive to visual impacts.

   While it is preferable that all timber harvesting operations be designed with aesthetics in mind, it is particularly important when the harvest area will be used or seen by the public. Areas that are adjacent to public roads, recreational areas, and recreational trails will require more careful planning. Clearcuts, shelterwood cuts, and patch cuts that occur on hillsides are also likely to be visible to the public. A United States Geological Survey map can help determine what areas of the cut may be visible and from where. If a cut is likely to be seen in the foreground (immediately adjacent to the viewer), aspects of the harvest such as slash, debris, and exposed earth will be important as well as the size, shape, and edges of the cut. When a cut is to be seen in the middleground or distance, details will be less significant, but the overall form of the cut and its contrast with the surrounding landscape will become important considerations.

Regional differences may also be important in determining public reactions to cutting practices. In portions of northern Vermont, larger clearcuts and seed tree cuts are more common. Much of southern Vermont, on the other hand, is more densely settled, and a large clearcut would not only be more noticeable, but appear starkly out of context. Both local public sentiment and the character of the surrounding landscape should also be part of determining how sensitive a site may be to the aesthetic impacts of harvesting operations.

3. Guidelines for minimizing negative visual impacts of timber harvesting operations from public viewing areas.

   a) Harvesting

   - Avoid "economic clearcuts" because they are likely to leave poor quality, spindly trees in the cut area. In almost all cases a thorough clearcut in which all trees are removed would be preferable. If trees are to be left as a seed source, leave significant groupings that have feathered rather than abrupt edges, or individual trees that retain lower branches and are sturdy enough to remain upright.
   - Avoid all cuts on or near the ridgeline or tops of hills except selection cuts in which a small basal area is removed. If a cut must occur on a ridgeline, the edges should be feathered, and it should be designed (shaped) to look like a high meadow. (This can work well on low ridges in areas where such ridgetop pastures are typical; it will be far less successful where the surrounding landscape is predominately wooded and fairly uniform in appearance.)
   - Avoid abrupt edges to cuts. Design a cut to have feathered edges (a natural transition from small shrubs to large trees, or low branching trees along the edge). This can often be achieved by following historic patterns such as old fields, fencelines, or small streams or drainageways. Even though old fields and fencelines may represent straight lines, the size, stature, and crown configuration of the residual vegetation along the line oftentimes produces a view that is not abrupt and offensive.
   - Reduce the size of clearcuts or seed tree cuts that are highly visible to public areas. Cuts over 30 acres appear quite large in most areas in Vermont. Larger cuts can be broken into smaller areas that appear in scale (of similar size) with other openings in the area.
   - Design the shape of cuts to be similar to other openings characteristic of the area, especially open meadows or pastures. Long straight edges, especially those that go straight up

a hillside, may create a strong contrast with the surrounding landscape, especially where the surroundings are predominately wooded.

b) Landing Areas

- Where the landing area is small and the harvesting operation is of short duration, a landing area that has been cleaned and seeded can create a pleasant opening along the road or trail-side. Slash and debris should be removed or out of sight. If a layer of wood chips exists, it should either be spread out or covered with dirt and seeded to insure a grassy cover.
- Large landing areas may be set back from a road or trail so that neither the landing area nor the harvest area are visible. This can be an advantage also in areas where trash and debris are likely to be left after public use.

c) Slash

- Slash, including leaning and hanging trees and branches, creates one of the most significant eyesores from harvesting operations. Slash should never obstruct trails. Slash that will not completely disappear within one year should be removed to at least 200 feet from public viewing areas. Large limbs left where they fall should not be visible from public viewing areas. Slash that is close to the ground or left in small piles may be less significant in areas that are only used in winter, such as snowmobile trails.

d) Buffers

- The width of a vegetative buffer will depend upon the screening ability of the trees in the buffer. A buffer of entirely deciduous trees may not be effective in the winter months unless it is very wide. Evergreen trees that have lost their lower branches may also be less effective.
- At least one forest products company is using a technique of making a narrow linear cut in front of areas which they plan to cut a few years hence. Within this narrow border cut, a dense thicket of new growth results which effectively screens the cutting beyond. This technique may not be appropriate along particularly scenic roadsides where the roadside vegetation itself is valued for its visual qualities.
- A well designed cut, especially one that improves aesthetic qualities, may not require a buffer.
- Buffers are not always effective, especially where cuts occur along hillsides and are seen at some distance from the cut area.

e) Other design considerations

- Roads can be aesthetically pleasing, especially if they are of minimum width, designed with the natural contours of the land, curve out of sight, and avoid long straight stretches.

- Exposed earth and large areas covered with chips where no revegetation has occurred can create eyesores. Reseeding is usually desirable in areas where natural revegetation may proceed slowly.
- Visible stumps over one foot in height should be avoided.

APPENDIX D:

Management Guidelines for Enhancing Archaeological Site Preservation in Timber Harvesting Operations

MANAGEMENT GUIDELINES FOR ENHANCING ARCHAEOLOGICAL SITE PRESERVATION IN TIMBER HARVESTING OPERATIONS

A number of management practices are currently in use on national forests and have enhanced site preservation (David Lacy, archaeologist, Green Mountain National Forest, personal communication). These include:

- using existing town, farm, and old logging roads during timber harvesting operations, although care must be taken if a road needs to be widened or straightened;
- establishing a "no cut" or "no disturb" buffer zone of at least 100 feet around all foundations;
- maximizing over-snow, winter logging in areas surrounding historic or potential prehistoric sites (Philipek 1985);
- using horses or farm tractors in smaller cut areas or in the vicinity of known or suspected sites;
- girdling, rather than cutting, trees in or near foundations where the goal is to thin or create wildlife openings; and
- using existing openings and breaching stone walls only when absolutely necessary.